Engineering News

Vol. 67, No. 12. 505 Pearl Street, New York. March 21, 1912.

Reinforced-Concrete Viaduct Carrying a Seattle Street over Railway Yards

By E. E. Adams*

For several years past there has been a gradual opening of vast reclaimed tide-land areas in the southern part of the city of Seattle, and an invasion of the new territory made by various business corporations which demanded permanent street improvements and facilities to handle the greatly increasing street traffic.

The most extensive of these improvements are those undertaken by the Great Northern Ry. in the construction of the large terminal yards, lying south of Jackson St. and west of Fourth Ave. South (see Fig. 2), and occupying in all many city blocks. The first of this work was started in 1904, when the railway completed a double-track tunnel under the city of Seattle, with its southern portal at Washington St. and Fourth Ave. South, from which the tracks passed in open cut alongside Fourth Ave. to the King St. Station and beyond into the railway yards, used by the Great Northern and the Northern Pacific railways. All of these yards and the tracks from the tunnel are at an elevation some 38 ft. below the adjacent street grades, so that the streets had to be carried either on retained fills or on viaducts alongside and through the railway property. In this original construction the west line of Fourth Ave. formed the east line of the railway cut and was held, from the portal of the tunnel to Jackson St., by a 38-ft. reinforced-concrete retaining wall, while from Jackson St. south the avenue was carried on a wooden viaduct. Some years later the Oregon-Washington R.R. & Navigation Co. built a reinforced-concrete viaduct on the east half of Fourth Ave. south of Jackson St., where that avenue adjoined its property and terminal station (see Fig. 2). The Fourth Ave. retaining wall, built in 1904 by the Great Northern Ry., was at the time one of the highest in existence and attracted considerable attention in the engineering world. It was completely described by C. F. Graff, of the Great Northern Ry., in Engineering News, Mar. 9, 1905, p. 262.

The most recent improvements include the demolition of this old retaining wall to permit the construction of a new wall giving more space for the railway tracks and the erection of a reinforced-concrete viaduct carrying the west half of Fourth Ave. south of Jackson St. This work has been done by the Great Northern Ry. at its own expense in return for certain city franchise privileges.

Fig. 2 gives the general location of the new improvements and Fig. 3 a more detailed plan of the work. As shown there, the old retaining wall was allowed to stand between the tunnel portal and south line of Main St., but was removed from Main St. to Jackson St. to permit of the construction of another retaining wall farther back under Fourth Ave., and provided with cantilever beams on which Fourth Ave. is carried. From Jackson St. south the west part of Fourth Ave. is carried on a new concrete viaduct supplanting the old wooden one. The overhang of Fourth Ave. at the retaining wall becomes so great as it approaches Jackson St. that additional columns are provided between the railway tracks, which makes the structure at this point half viaduct and half retaining wall. As will be noted, the additional space gained by

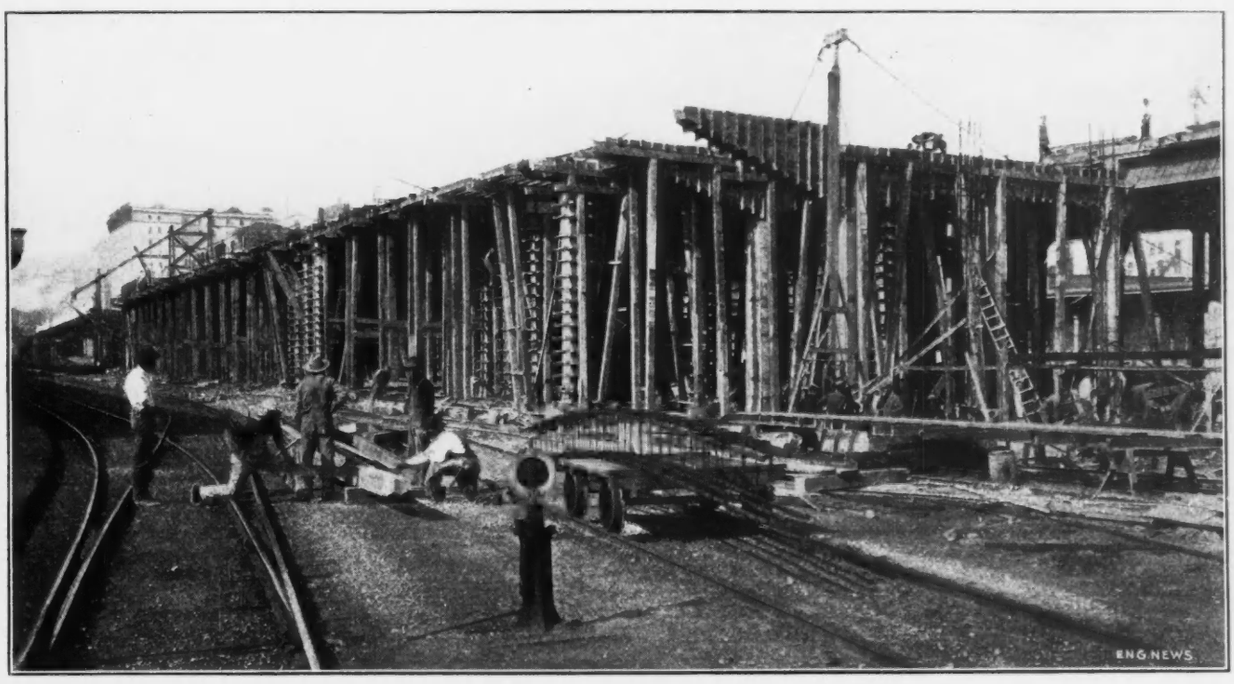

Fig. 1. Fourth Ave. Viaduct, Seattle, Wash., Under Construction

[Looking north along tracks of Great Northern Ry. Old concrete viaduct built by Oregon & Washington Ry. & Navigation Co. at extreme right.]

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moving the wall and the space under the viaduct is used for extra tracks for the Great Northern Ry.

The design of the structure is best shown in the sections in Figs. 4-6. From Fig. 3 it will be noted that the line of the wall cuts across the line of Fourth Ave. The last cantilever shown is at counterfort 10 (see Fig. 3). Concrete piles were designed for the entire structure, but were abandoned for the retaining-wall section, as described below.

At each expansion bent, built-up steel box girders, inclosed in concrete, were

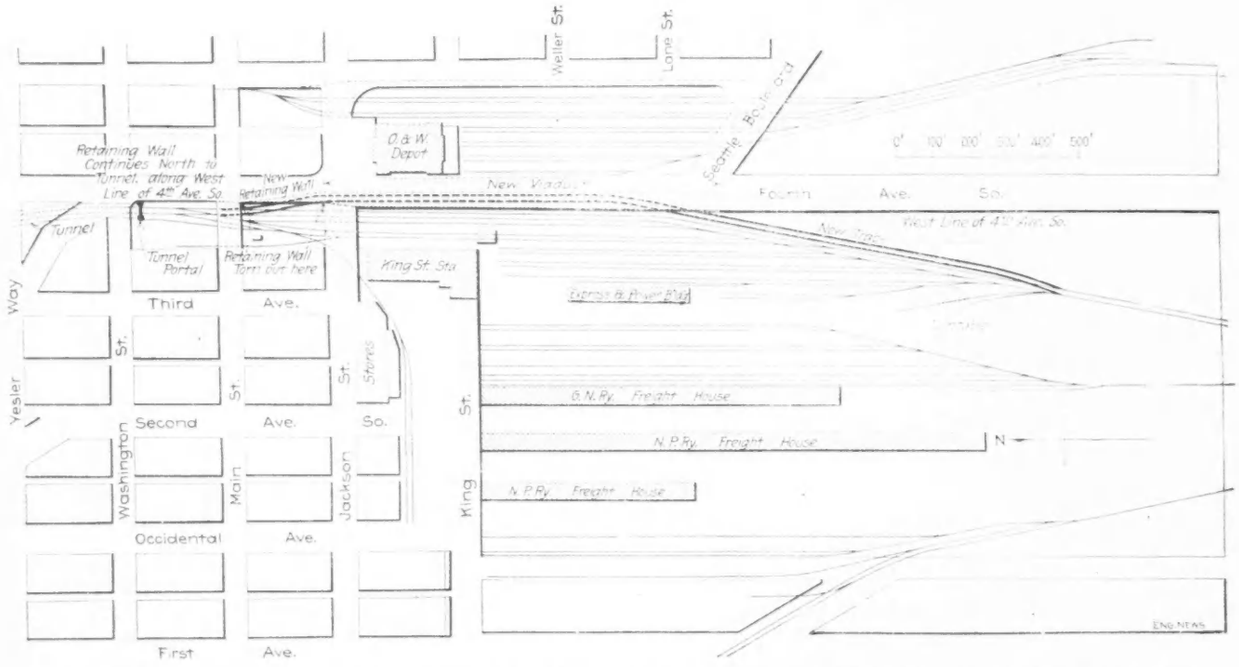

FIG. 2. MAP OF PORTION OF THE CITY OF SEATTLE, WASH., SHOWING RECENT IMPROVEMENTS IN THE VICINITY OF KING ST. TERMINAL OF GREAT NORTHERN RY.

tractors were successful and the work was allotted to independent contractors in the following arrangement: (1) the concrete piling; (2) the wrecking of the old wood bridge on Fourth Ave. and the constructing of the footings, columns and superstructure of the concrete viaduct; (3) the tearing down of the old concrete retaining wall, and the constructing of the new concrete structure indicated as the subway; (4) the paving of the roadway on the completed structures; (5) the railway company furnished all the material, consisting of cement and sand, gravel, reinforcing rods, structural steel, waterproofing material, paving metals, etc., etc., for all the contractors as needed in their respective part of the work.

on a curve, thus making a different condition at each counterfort of the retaining wall. From counterforts 1 to 7, the curb line of the street pavement is inside the face of the wall, thus demanding such a design as is shown for counterfort 3 in Fig. 4. From counterfort 8 to 10, the curb line lies outside the face of the wall and there is a long overhanging beam to carry the sidewalk, as shown in Fig. 5. From counterfort 11 south the retaining-wall construction is followed, but there is in addition a regular viaduct section carried on a post between the tracks and another formed against the retaining-wall face. Fig. 7 is a view taken from counterfort 2 looking south along the wall. The last cantilever shown is at counterfort 10 (see Fig. 3). Concrete piles were designed for the entire structure, but were abandoned for the retaining-wall section, as described below.

At each expansion bent, built-up steel box girders, inclosed in concrete, were used and the movement of the expansion slab takes place on a sheet of zinc, which was inserted between the slab and the beam. The zinc was placed there to eliminate abrasion of the movable concrete slab on the fixed concrete beam (see Fig. 6).

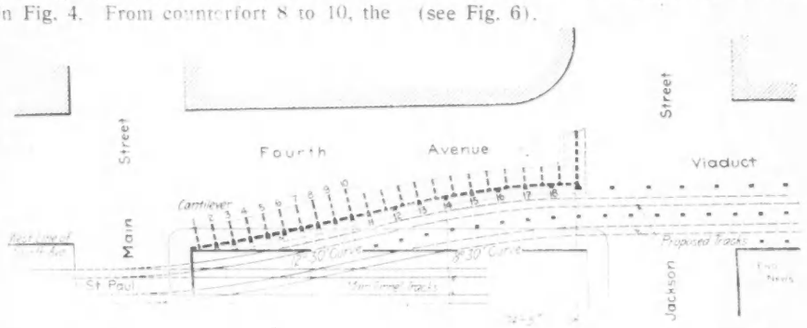

FIG. 3. PLAN OF NEW RETAINING WALL, GREAT NORTHERN RY. TERMINAL IMPROVEMENT, SEATTLE, WASH.

CONSTRUCTION

After the preliminary arrangements were made between the city Engineering Department, the Board of Public Works and the railway company, relative to the allowable unit stresses, the dead and live loading, and the scheme of handling team and street-car traffic, during the construction, the plans were accepted and bids taken for the work. Several con-

The work of tearing down the old wood viaduct began the first part of June, 1911, and the space was immediately cleared so that the large pile drivers could gain access to the site of the work.

Considerable difficulty was encountered after the concrete pile-driving started. The first trouble was experienced on account of the extreme depth to which the piles had to penetrate to meet sufficient requirements for the superimposed loading, which in some places reached a maximum loading of 22 tons per pile.

The ground along the site of the viaduct was formerly undulated tide lands, which later having been filled some 10 to 25 ft. made unreasonable length and excessive cost for the concrete piles; hence after several tests had been made in the heavily saturated soil, it was decided to abandon the concrete piling for

the south half of the viaduct and resort to wood piles, which would have to be as long as 80 ft. in some places. This in turn necessitated lowering the cutoff of the piles to the water-saturation line and crete piling would be used and cut-off would be near the surface of the ground in dry excavation, the contractor was instructed to do all extra work of additional excavation, placing sheet-piling, pump- proper the concrete piling was used, as the original shore line crossed the site of the improvement in this location and sufficient penetration was secured for the loading, while for the remainder of the

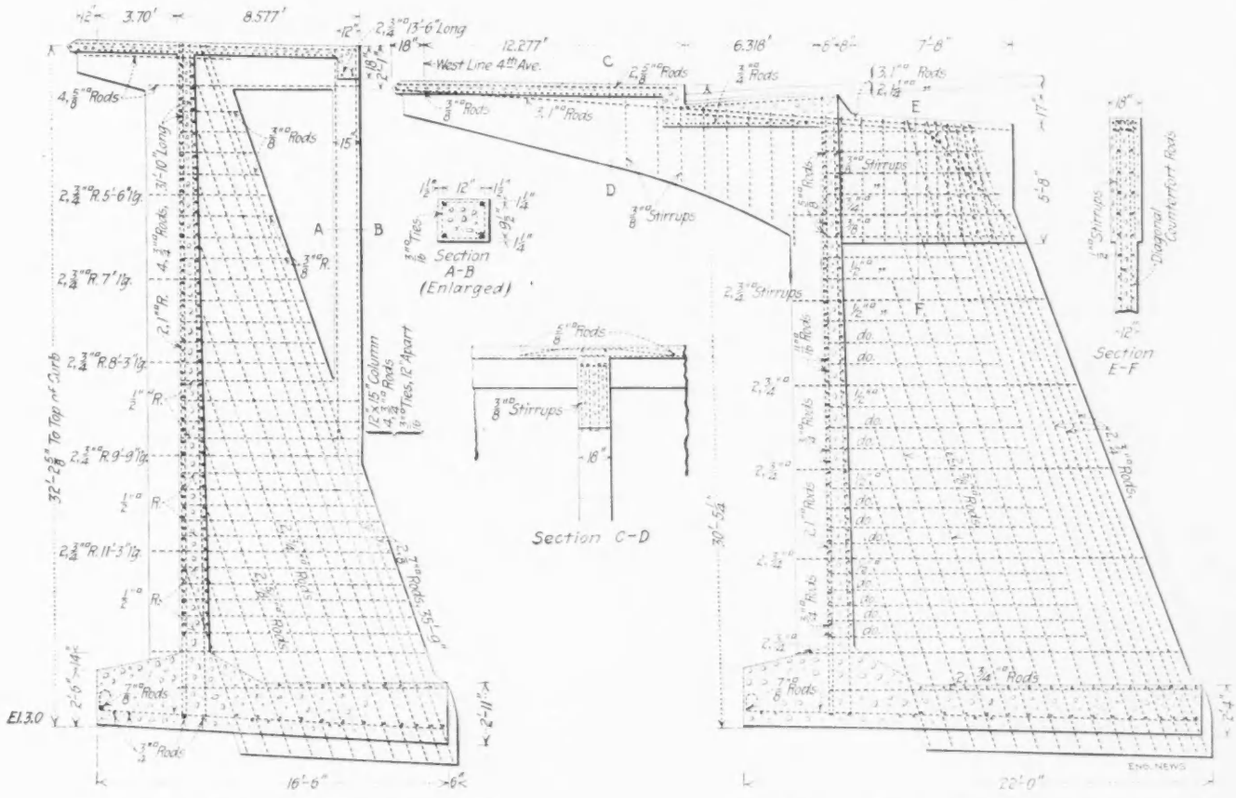

FIG. 4. TYPICAL SECTION COUNTERFORTS 1-7

FIG. 5. TYPICAL SECTION COUNTERFORTS 8-11

FIGS. 4 AND 5. SECTIONS OF THE RETAINING WALL

a re-design of the concrete footings. Inasmuch as the contract for the construction of the viaduct was let on a lump-sum basis on the assumption that con- ing, removing old logs and débris covered with earth from the tide-land fill, on a force-account basis.

For the north 20 bents of the viaduct footings, wood piling was used throughout, the piles ranging up to 75 ft. below cut-off.

While the excavation was progressing

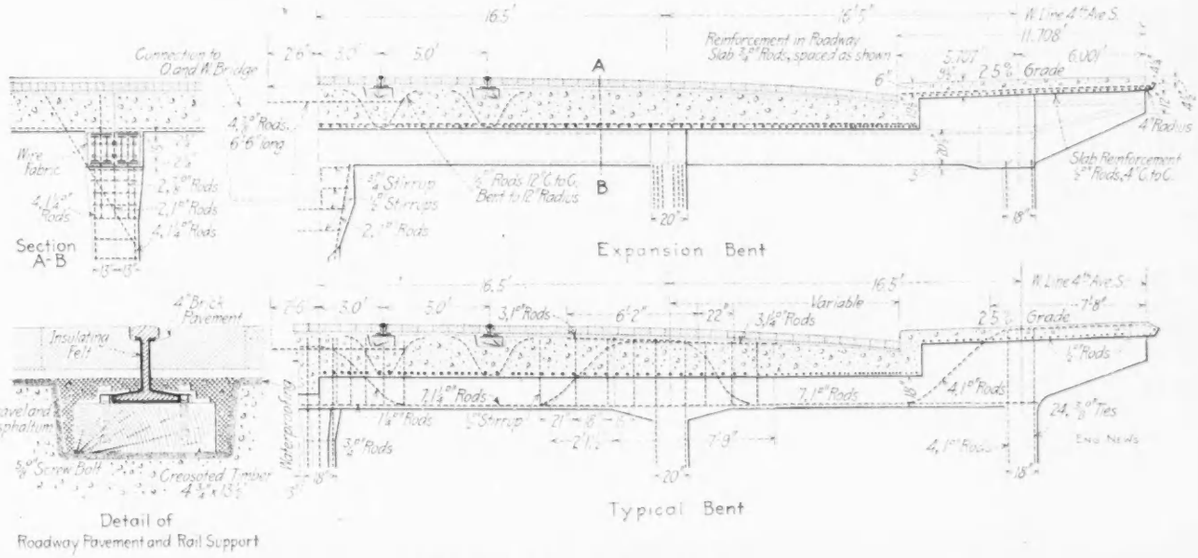

FIG. 6. SECTION THROUGH VIADUCT

in the retaining-wall section, a peculiar change in the formation of the soil was encountered, and for the entire length of the footing slab of the retaining wall, nature had conveniently arranged a hard soil of cemented gravel and hardpan; whereas a short distance south of this location, on the site of the viaduct, long piles were needed for the foundations. The retaining-wall footings had been designed for pile supports, but they were then changed and a uniform bearing of about 2.5 to 3 tons per sq.ft. adopted.

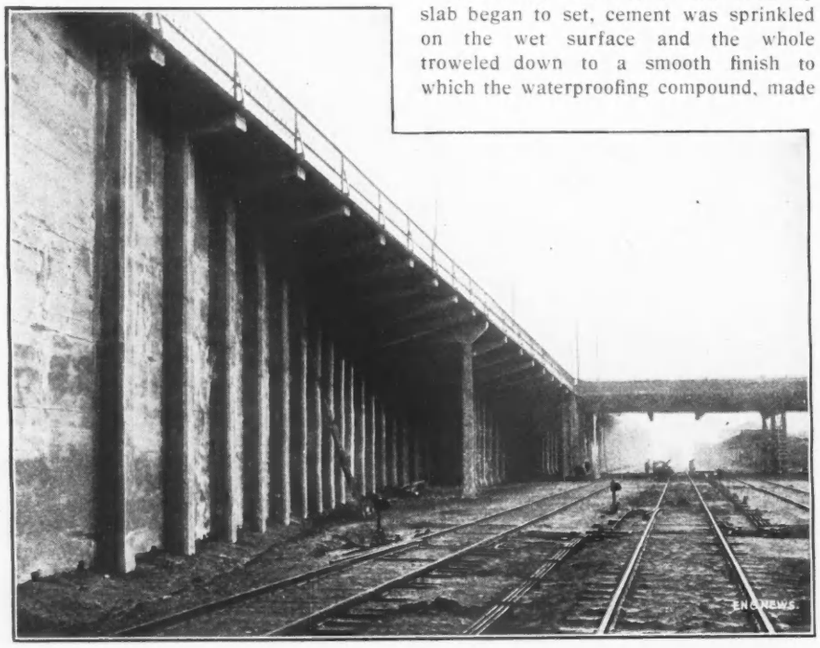

FIG. 7. VIEW OF COMPLETED VIADUCT, LOOKING SOUTH TOWARD JACKSON ST. BRIDGE

The placing of the concrete footings and column steel rapidly followed the pile-driving, and the superstructure forms followed in quick succession. The sand and gravel were elevated from the railway company's cars to the bunkers by a clam-shell trip hoist. The delivery of these materials to the mixing hopper was effected by gravity, and after the concrete was mixed in a batch mixer it was again elevated to auxiliary hopper bins on the upper surface and conveyed to its final location by hopper buggies, wheeled along portable platforms.

Excellent spirit prevailed upon the work, and at times, when concrete was poured, as many as 350 cu.yd. of concrete was placed per working day of eight to eleven hours, or a section of the viaduct completed from one expansion bent to another, these being spaced 90 ft. apart.

In order to eliminate any possible settlement of the forms after the concrete was placed upon them, all of the shoring posts were blocked up on the concrete-column footings, which capped the piling, and thus no settlement took place. The wedges and keys were carefully watched during the placing of the concrete.

Before the concrete in the roadway slab began to set, cement was sprinkled on the wet surface and the whole troweled down to a smooth finish to which the waterproofing compound, made of tar, kerosene and cement, was later applied. Great care was exercised in troweling the roadway finish to get the proper crown of street, to make the slab more impervious to water and also to make it easier to apply the waterproofing compound. This compound was applied while hot with ordinary roofing brushes, and, at each expansion bent, hot asphalt was poured into the open joint. This made the whole surface practically waterproof and eliminated dripping and seepage down on the tracks underneath.

After the viaduct structure had been completed on each side of the concrete plant, this plant was torn down and the piles driven for the remaining part of the structure. The concreting materials were then delivered by teams to the superstructure, where a portable concrete mixer was used to complete the gap between the two completed parts of the work.

The part of the overhead roadway on Fourth Ave. South, built by the Oregon-Washington R.R. & Navigation Co., was connected to the new viaduct by tie rods projecting from the old structure These rods are shown in the view in Fig. 1.

TEARING DOWN OLD CONCRETE WALL

At the time of the construction of the viaduct, another contractor was having considerable difficulty in removing the old concrete wall. Various methods were used in this removal work. Drills, operated by compressed air, were used and holes drilled in the old wall slab and the counterforts in a horizontal line, wedges being inserted and blocks of the concrete broken away. This method proved too costly, so finally a steel shaft, 6 or 8 ft. long, weighing about two tons, was swung from a boom of a stiff-leg derrick and the wall rammed away between the counterforts, and finally the counterforts were rammed down. The embedded reinforcing rods, which were not broken by the ram, were cut by a steel saw.

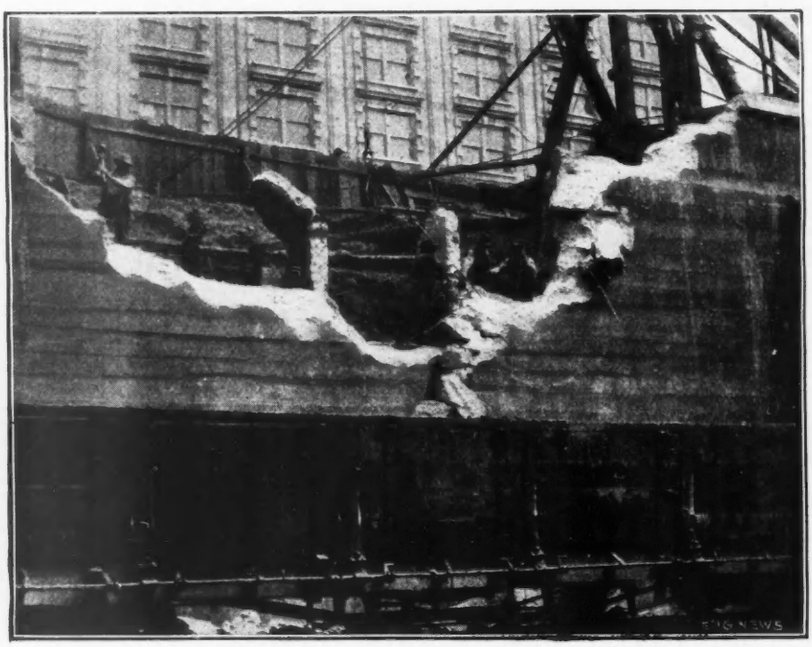

FIG. 8. TEARING DOWN OLD RETAINING WALL TO MAKE ROOM FOR NEW WALL

Blasting was also resorted to, but the size of the charge of powder was limited and the city authorities discouraged the method as the danger to near-by buildings was too great. However, most of the base of the old wall which had to be removed was torn out by blasting. Fig. 8 shows the razing process under way.

The old reinforcing rods were found to be in good condition and no deterioration was noticed, except the ordinary amount of rust or discoloration which forms on rods while in transit to the work or from standing in the material yard. Examination was also made to determine whether the rods had been affected by electrolysis. To the eye no apparent damage had been done, but the writer noticed that after several of the large high-carbon rods had been cut by the steel saws the steel filings adhered to the end of the rod, similar to the arrangement of filings on the pole of a magnet. It seemed at first that electrolysis had magnetized the rods. This was not so, however, as the filings would soon drop from the end of the rod, and it required close examination to even observe the filings at all.

The writer also noticed that the concrete at the top of the old wall, near the coping, contained many air holes. The concrete when broken seemed to be dusty and dry and caused a smarting in the nostrils of the laborers, similar to the effect of lime plaster. This was probably caused by the concrete being mixed with small amount of water, which was then the practice.

Approximately, 600 cu.yd. of concrete were removed, at an average cost of $5.85 per cu.yd., and about 10,000 cu.yd. of earth material removed from behind the wall. The earth was excavated by an orange peel. All this work was slow and tedious and routing the street cars and overhead traffic proved a source of great expense. Finally piling was driven as far as possible in the ground along the margin of the new cut and racker braces inserted to relieve the thrust from the embankment and the over-head street-car loading, but this proved to be an expensive method of holding the embankment and street above, but cheaper than cribbing and building a false overhead roadway.

Street Arrangements

During the progress of the work gas mains, telephone and telegraph conduits, electric-power lines and street-lighting conduits had to be cared for, which added considerable expense to the undertaking, but served to bring about a permanent arrangement of these public utilities.

Quantities

The following material was used for the two structures: 10,000 bbl. cement, 5200 cu.yd. gravel, 3500 cu.yd. sand, 56 tons structural steel and 430 tons reinforcing rods. A 1:2:4 mixture for the concrete was used, and it was made very wet; 235,000 ft. b.m. second-hand lumber and 135,000 ft. b.m. new lumber was consigned to the work for forms and shoring, but on account of removing and again using the forms about 518,000 ft. b.m. lumber was handled, at a cost of $16 per M. The shoring posts were 7x9 in. and after the completion of the work were cut into railroad ties. The average cost per cu.yd. of reinforced concrete in place, including forms, labor, steel, cement, sand and gravel, figured from $14 to $15 per cu.yd. The average cost of the steel in place, per cu.yd. of concrete, came to $2.30 for this type and amount of reinforcing. The average cost of the cement in place, per cu.yd. of concrete, came to $2.96. The average cost of the sand and gravel in place, per cu.yd. of concrete, came to $1.35.

By making this improvement the railway company acquired about 40,000 sq.ft. of valuable track space and thereby added about 5000 lin.ft. of additional track for the Seattle Terminal Station.

This work was carried on under the direction of A. H. Hogeland and Alex. Stewart, chief engineer and assistant chief engineer of the Great Northern Ry., respectively. The structures were designed by A. Münster, consulting engineer, Seattle, Wash. The writer was assistant engineer during construction.

Specifications for Overhead Wires Adopted by the City of Seattle, Wash.

By H. L. Estep*

In the issue of Engineering News for May 12, 1910, there was described a set of standard specifications for underground construction adopted by the city of Seattle, Wash. The Public Utilities Department of Seattle has now worked out additional specifications covering the installation and operation of electric wires, appliances and apparatus upon and over the streets and public places of the city.

The most significant clause in these specifications is one providing for the joint use of poles by rival corporations. Through its operation, one line of poles will serve instead of three now maintained on one side of the streets by the two telegraph and telephone companies, while another single line on the opposite side will accommodate the wires of both the municipal and the private light and power enterprises. The public-service corporations have appreciated the economy of the scheme and concur in approval. The resulting improvement in the appearance of streets is obvious, and it simplifies the inspection devolving on the public-utilities department.

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The Superintendent of Public Utilities, upon receiving an application for a permit to set poles, is required to notify all parties apt to be interested, and they must reply within six days, stating what space and rights are desired. In urgent cases, a reply by telephone, confirmed later by letter, may be required within 24 hours. The size of the poles set will then be regulated so as to allow sufficient space for all companies desiring an interest.

If an application is made to set poles along an existing line and if the Superintendent of Public Utilities finds that there is sufficient space available on the existing poles to accommodate the company making application, he will so notify the applicant, advising that satisfactory arrangements be made with the owners of the existing line. If there is no space available on poles already set, the permit is granted—subject to the condition that the new poles shall be of sufficient length to accommodate the wires of the existing owners and that satisfactory arrangements be made for transferring the old wires and for the removal of the old poles.

Applications may also be made for permits to string wires on poles in which the applicant has no equity or interest. In case such space is available the Superintendent of Public Utilities may grant the desired permission, subject to the condition that satisfactory arrangements be made with the owners of the pole.

It is required, in general, that all light and power wires shall be carried on one side of each street, or alley, and the telephone and telegraph wires on the other side. Wherever there are parking strips, the poles are to be located in them; in strips of 5 ft. or less, the pole is to be centered 18 in. from the face of the curb. In parking strips exceeding 5 ft. in width, the poles are to be centered on a line midway between the outer edge of the sidewalk and the face of the curb, unless local conditions render other direction by the Superintendent of Public Utilities necessary.

Wherever it is practicable, the location of driveways into private property will be adjusted so as to avoid the moving of poles, but where existing poles unavoidably interfere with access to property, upon notice from the Public Utilities Department, they shall be moved.

Transformers cannot be located on junction poles and series arc lamps cannot be attached to poles on which one or more transformers are located, unless arrangements are made for the removal of the transformers. In case the arc lamps are suspended over street intersections, the pole on which the arc-lamp switch is placed is the one on which transformers are not permitted.

The specifications provide that the poles themselves may be of wood, iron or such other material as may be approved

by the Board of Public Works; if of wood they must be of cedar, sound, straight, free from large or dead knots and dry cracks; butt rot in the center, including small ring rot, must not exceed 10% of the butt area of the pole. Only one crook is permitted in a pole, that one in but one direction and of a sweep not to exceed 1 in. in every 5 ft.

The poles must have a minimum top diameter of 7 in., except telephone and telegraph poles, which may have a top diameter of 6 in., and the butt diameter, measured at what would be the ground line, must be as follows:

Length Feet	Max. Butt Inches	Min. Butt Inches
35	24	12
40	24	13
45	24	14
50	26	14
55	26	14
60	28	15
65	28	16
70	28	18
75	29	20
80	29	22
90	30	23

No poles are permitted less than 28 ft. in height above ground and they must be buried at least 5 ft. and as much more as is necessary to safeguard against leaning or falling. The companies are forbidden to shave or peel their poles on the graded streets. Iron steps are not permitted on poles within less than 8 ft. of the ground, although in some cases wooden steps may be constructed within that limit.

Existing poles will be used at crossings wherever it is possible, provided that the space so taken does not interfere with the space required by the owner of the poles. In this as in all other cases, the Public Utilities Department is made the arbiter between the companies. No guy poles are to be set where a pole of the same or any other system can be effectively used. Poles thus used are, of course, to be supported, braced or guyed where it is necessary, to hold the pole in its normal position. The several crossarms on joint poles must be designated by the initial or name of the owner.

The specifications provide further, that all wires carrying a tension of 10,000 volts or over must be maintained at a height of not less than 45 ft. from the ground and the wires must be not less than No. 2 B. & S., medium hard-drawn copper. Wires which carry over 10,000 volts shall not cross wires carrying 10,000 volts or less, at a distance less than 7 ft. above, if over or on a pole carrying the line crossed, and not less than 6 ft. above, if the crossing is made over a span between poles; nor may they parallel such wires at a distance of less than 5 ft. Wires carrying 700 volts or over must not be carried within less than 22 in. of pole centers, with the exception of wires between line wires and lamps on series street-lighting circuits on poles not carrying transformers.

The minimum height of trolley wires is set at 14 ft. and the maximum height at 21 ft. above the surface of the ground or street grade. Span wires must be not less than ¼ in. in diameter, and must have a tensile strength of at least 3050 lb. per sq.in.; the maximum sag permitted is 1 ft. in a 20-ft. span. There must be at least one circuit-breaker (insulator) of approved type inserted not less than 6 ft. from the pole in every span wire between each pole and trolley wire.

Swing-arm construction will be allowed only in alleys in residential districts and, where allowed, primary-circuit wires and those carrying a potential in excess of 600 volts are to be supported on those pins farthest from the pole and in no case closer than 3 ft. to pole or property line.

By September, 1912, the electric wires in a large section of the down-town district of Seattle are required to be placed underground and it is interesting to note that Paul P. Whitham, who as chief engineer of the Public Utilities Department of Seattle, drew up the foregoing specifications, has worked out an arrangement by which the public-service corporations affected are building joint conduit. A large saving in cost and a better use of street space is resulting.

A Method for Computing the Size of Spillway for a Dam

By H. K. Palmer*

The necessary proportions for the spillway of a dam depend not only on the amount of water flowing into the reservoir, but on the storage capacity of the reservoir and the duration of the flood. It is obvious that, where the area of the reservoir is large and the duration of the flood short, most of the water will be stored and the flow over the spillway will be comparatively small. On the other hand, if the reservoir be small and the flood long continued very little water will be stored and the spillway will have to carry the full amount of the flood.

The simplest case to consider is one which seldom occurs in practice; that is, one in which the flood starts suddenly, flows for a limited time with a constant flow, and stops as suddenly as it began, or the flow diminishes to the size of the maximum flow over the spillway. Whether the error introduced by this assumption is greater than the probable error in the assumed volume of flow must be left to the judgment of the engineer.

Let

F = Flow into the reservoir, cu.ft. per sec.,
h = Depth of water in reservoir above level of spillway, ft.,
L = Length of spillway, ft.,
Q = Discharge of spillway, cu.ft. per sec.,
a = Area of reservoir at level of spillway, sq.ft.,
A = Area of reservoir at level of spillway, acres,
b = Increase in area of reservoir per foot of depth, sq.ft.,
B = Increase in area of reservoir per foot of depth, acres,
T = Duration of flood.

For any depth of water, h, the area of the reservoir is

$$Area = a + bh$$

and the discharge of the spillway is approximately

$$Q = 3\,Lh^{\frac{3}{2}}$$

The net increase in the contents of the reservoir will be $F - Q$ cu.ft. per sec., and the rate of rise of the water level will be expressed by the equation

$$\frac{dh}{dt} = \frac{F - Q}{a + bh} = \frac{F - 3Lh^{\frac{3}{2}}}{a + bh}$$

$$dt = \frac{a + bh}{F - 3Lh^{\frac{3}{2}}}\,dh$$

The integration of this last equation would give a relation between the time and depth of water flowing over the spillway, but the result is so complex that it

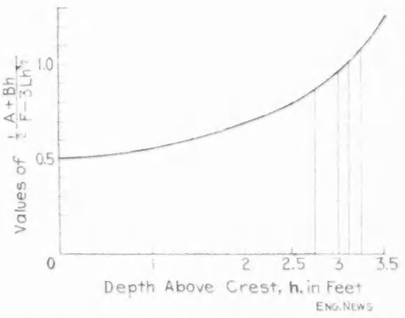

Fig. 1. Determining Maximum Flood Depth, in Simplest Case

is impracticable. Integration by mechanical quadratures or by the following graphical method is much simpler.

If we plot a curve in which h is the abscissa and $\left(\frac{a + bh}{F - 3Lh^{\frac{3}{2}}}\right)$ the ordinate, then the integration of this expression will be the area between the curve, the X-axis and the two ordinates representing the limits of integration. This area will give us the time required for the water in the reservoir to rise from its initial height to the height of the upper limit of integration. Using the above notation, T would be expressed in seconds. For the ordinary case it would be much better to express this in a larger unit. Since,

1 cu.ft. per sec. = 2 acre-ft. per day

we can write the expression

$$T = \int_0^{h} \frac{A + Bh}{F - 3Lh^{\frac{3}{2}}}\,dh$$

where T is expressed in days and A and B in acres.

As an example of the above method, suppose it is required to find the depth of water flowing over a 30-ft. spillway when a flood of 1000 sec.-ft. flows for 2 days

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into a reservoir having an area of 1000 acres at the level of the spillway, this area increasing 10 acres for each increase of a foot in the depth of water above the spillway.

In this case

$F = 1000$ $T = 2$
$L = 30$ $A = 1000$
$B = 10$

h	$\frac{1}{2}(A+Bh)$	$3Lh^{\frac{1}{2}}$	$F-3Lh^{\frac{1}{2}}$	$\frac{1}{2}\frac{A+Bh}{F-3Lh^{\frac{1}{2}}}$
0	500	0	1000	0.50
1	505	90	910	0.55
2	510	256	744	0.69
2.5	512.5	355	645	0.79
3	515	468	532	0.97
3.5	517.5	590	410	1.26

Plotting the figures of the first column as abscissas and those of the last column as ordinates, we get the curve shown in Fig. 1. Measuring the area between the curve, the X-axis and any value of h will give the time required to raise the water to that height. Thus we find by trials that for

$h = 2.75$	$T = 1.67$ days
$h = 3.0$	$T = 1.92$
$h = 3.25$	$T = 2.20$

Since T is given as 2.0 it is evident that the required height is about 3.1 ft. Another trial, using $h = 3.1$, gives $T = 2.04$, which is more accurate than the assumption of the flood-flow is likely to be.

Where the depth of the spillway is limited, it is necessary to make several trials, using different values of L. Usually three or four trials are sufficient.

In case the engineer has any reliable records which would give him the form of the flood wave it is possible for him to take this into consideration, but the solution is more complex, as it can be done only by a series of approximations. Let ABC, Fig. 2, represent the flood wave, the abscissas representing the time and the ordinates the volume of water. In this case time should be expressed in days and volume in acre-ft. per day. The area between the curve and X-axis will then represent the total amount of water in acre-ft. that flows into the reservoir during the flood.

At the same time the spillway is discharging water, the flow starting from zero and increasing as the water rises in the reservoir. The discharge curve is represented by the line AD, Fig. 2. The area between the two curves represents the actual increase in the contents of the reservoir, or the volume of the water above the level of the spillway. The point where the two curves intersect represents the time and maximum discharge of the spillway, since after that time the spillway is discharging more water than is flowing in. The plotting of this curve is the difficult part of the problem.

The first requirement in this solution is a table, or better a curve, showing the relation between the quantity of water in the reservoir and the discharge of the spillway. A curve is preferable for this, since by using the same scale as in the flood curve the discharge can be transferred directly with dividers. Such a curve is shown in Fig. 3.

The next step is to assume that at the end of a certain time the spillway will be discharging a certain amount. As the discharge is very small at first this interval can be made rather large, ¼ or ½ day, for instance. This point should be joined with the origin by an assumed discharge curve. Next measure the area between the two curves from the origin to the assumed point, thus getting the amount of water assumed to be in the reservoir. With this amount find from Fig. 3 what the actual discharge should

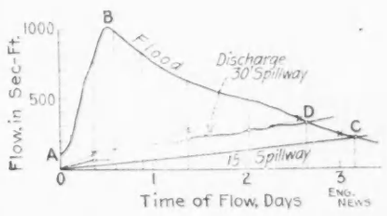

FIG. 2. TIME-CURVES OF FLOOD FLOW AND SPILLWAY DISCHARGE, TO DETERMINE MAXIMUM DISCHARGE

be. If we have assumed too great a discharge in the first place the amount of water in the reservoir will be too small and consequently the discharge over the spillway will be too small. Therefore the point should be located on the diagram between the assumed point and the one found from Fig. 3, but usually nearer the latter. Draw the discharge curve to this point and find the actual discharge as before. Usually not more than one

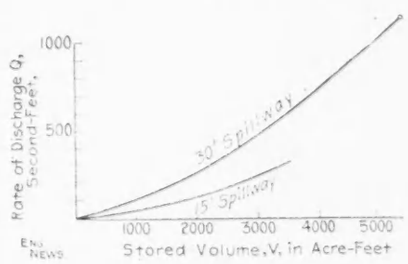

FIG. 3. CURVE CONNECTING AMOUNT OF STORAGE AND RATE OF DISCHARGE OVER SPILLWAY

or two trials will be necessary to find the point which will give the same discharge as was used in making the last trial. Having definitely located one point, another should be located in the same way, this time the assumed discharge curve being drawn from the point just found to the new point, and the area between the two curves being measured always from the origin to the point in question. When the whole discharge curve is plotted as far as the maximum discharge, we are apt to find that the assumed length of spillway does not give the desired proportions, in which case the whole must be done over again, using another length. However, the first discharge curve can be used as a guide and the work very much reduced.

Figs. 2 and 3 show the actual solution for a flood wave with a maximum discharge of 1000 sec.-ft. flowing into a reservoir with an area of 1000 acres at the level of the spillway, increasing by 10 acres for each increase of a foot in depth above the spillway. Points of assumed discharge are marked x and corrected and checked points are marked o. In two instances no corrections had to be made to the assumed point, and in the remaining instances only one assumption was necessary. The result showed that at maximum discharge 300 sec.-ft. would pass over a 30-ft. spillway with a depth of 2.23 ft. (line OD). The line OC gives the discharge for a 15-ft. spillway. This was found by making the discharge approximately half that of the 30-ft. spillway. The point of maximum discharge was the only one requiring any correction after measuring the amount of water in the reservoir. In this case the maximum discharge is 235 sec.-ft. at a depth of 3 ft. The time required to solve the above problem for the 30-ft. spillway was 50 min., and for the 15-ft. spillway 10 min.

When a flood wave of given form is superimposed on a previously existing flood flow, the discharge curve in Fig. 2 is to be started not at zero ordinate, but at a height above zero equal to $y = 3\,LH_0^{\frac{3}{2}}$, where H_0 is the depth over crest at the beginning of the flood wave. Then, assuming a point farther along on the discharge curve, the area between the discharge and the flood wave curves gives the net inflow. In Fig. 3 the abscissa values should be shifted to bring the zero to a point equal to the water stored above crest at the beginning of the flood wave, and the net inflow above determined is to be measured from this new zero; the ordinate at this point gives the spillway discharge, by which the assumed point on the discharge curve in Fig. 2 may be corrected.

While the method described in this article may not be the most accurate method of attacking this problem, its accuracy is well within the probable error of the assumed flood, for, no matter how great a flood we may have data for, there is always apt to be a larger one, and that is the one that should be allowed for. It is for this reason that the constant used in the weir formula in this case is taken as 3 instead of the more accurate value depending on the form of the crest of the weir.

Acknowledgment is due to C. R Olberg, Superintendent of Irrigation, U. S. Indian Service, for much assistance and advice in developing this method.

Typhoid Outbreak, Cedar Falls, Iowa

By A. L. Grover* and R. B. Dole†

The contamination of a public water supply derived from a large free-flowing spring in the limestone led to a sharp typhoid fever outbreak at Cedar Rapids, Iowa, late in 1911. The results of an epidemiological study of the outbreak are here given.

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†Chemist, U. S. Geological Survey. Published by permission of the Director.

The sudden severe epidemic of typhoid fever at Cedar Falls, Iowa, during November and December, 1911, offers such an excellent example of the evident pollution of a spring supply hitherto considered above suspicion that a brief review of the reports thereon is presented.

The city is situated on Cedar River, in Blackhawk County, seven miles above Waterloo, which attracted widespread attention in 1904 by a waterborne epidemic of typhoid fever.‡ It has a population of 5012 (1910), which is further augmented by about 1100 students at the Iowa State Teachers College within the city limits. It has been singularly free from typhoid fever for many years, and the present city supply from springs has been generally considered safe for domestic use.

During July, 1911, four cases occurred, two of which were apparently due to swimming in the sewage-polluted river and two of which were traced to a carrier. No other cases were reported until late in the fall and these four have no apparent connection with the alarming outbreak in November.

The following remarks on the recent epidemic are based on complete histories of eighty cases investigated by Doctor Grover between Nov. 10 and 18. All those affected were white people, 40% being males and 60% females. The cases were distributed over the entire city; there was somewhat more infection around the college than elsewhere, a condition doubtless due to the fact that the population in that section of the city is somewhat more concentrated than elsewhere and the students also are at the so called "typhoid age."

The age distribution is more nearly like that found in waterborne epidemics than that in epidemics caused by milk, as is shown by the following table:

PERCENTAGE OF TYPHOID FEVER AT SPECIFIED AGES DURING VARIOUS OUTBREAKS

Age in years	Waterville,* Maine, 1903, caused by water	Stamford,* Conn., 1895, caused by milk	Des Moines,* Iowa, 1910, caused by water		Cedar Falls, Iowa, 1911, Grover, 80 cases
			Sayler	Lumsden	
0–10	17	35	14	20	15
10–20	38	24	45	44	38
20–30	26	23	24	28	32
30–40	10	12	11	4	11
40–50	4	5	5	4	3
50–70	5	1	1	0	1
	100	100	100	100	100

(*) Lumsden, L. L., Report on an Outbreak of Typhoid Fever at Des Moines, Iowa, in 1910. Public Health Reports, P. H. and M. H. S., Vol. 26, No. 4, Jan. 27, 1911.

Careful investigation of the milk supply cleared that possible source from suspicion. No milkman had a disproportionate number of cases among his customers and 16% of the patients denied using milk in any form whatever. The virulence of a milk infection usually causes the appearance of several cases in a family, but more than one original case per family occurred in only a few instances at Cedar Falls. The age distribution and the general history of prodromal symptoms also corroborate the other evidence clearing the milk supply. The possibility of infection from ice cream, butter, fruit, fresh vegetables, and oysters was investigated and it was ascertained that the epidemic could not be attributed to any of these sources.

The city-water supply was used in all the residences in which fever developed in the city except two; the patient in one of these houses drank city water at his place of business and the other attended a public school, where he drank city water. Three patients outside the city limits lived at houses with private wells, but all used city water either at their places of business or during their daily trips to town. The common use of city water, the season of occurrence of the disease, the extent, distribution, and explosive character of the outbreak, together with the lack of any other common cause, all point to the city-water supply as the source of infection. If these factors are considered in connection with the possibilities of infection of the supply, the irresistible conclusion is that the trouble should be laid to water infection.

City-water Supply

The water supply is taken from springs on the bank of Dry Run, 600 ft. from the confluence of that watercourse with Cedar River, and the average daily consumption is about 340,000 gal. The springs, which issue from limestone 1 or 2 ft. above the level of the bed of the run, are inclosed by an arched top of masonry coated with cement. A cast-iron overflow pipe into Dry Run is fitted at its lower end with a ground flap valve intended to prevent entrance of river water during floods. Several other large springs gush forth within a few hundred feet and all are probably interconnected by rock channels. The discharge of all has been estimated at 6000 gal. per min. As the water issues in large volume with little head it apparently comes from well defined rock channels and does not run out by slow seepage. A cast-iron pipe under the run connects the masonry with a plank conduit about 1000 ft. long running to the cistern at the pumping station, to which water flows by gravity. The conduit lies 2 to 10 ft. underground and is below groundwater level in the broad low-lying flat that it traverses. The pump cistern of brick is believed not to be watertight.

The rock from which the springs issue, known as the Cedar Valley limestone, underlies deep drift in a large area of Iowa, but at Cedar Falls it forms the beds of Dry Run and Cedar River and it is covered throughout a greater part of the city by coarse gravel only 5 to 15 ft. thick. Where it is exposed in quarries it is seen to be full of cracks and crevices, and the existence of well worn waterways in it makes it apparent that solution channels of appreciable size have formed along the joints and bedding planes. Many old dug wells penetrating the limestone in the city are used for the disposal of slops and other wastes. These relations are rendered the more serious as the springs emerge at the lowest elevation in town, except a part of the bed of Cedar River. At times of flood the river backs up Dry Run, covering the overflow pipe of the spring and sometimes the flat crossed by the wooden conduit. It is currently reported that the supply is sometimes turbid during floods.

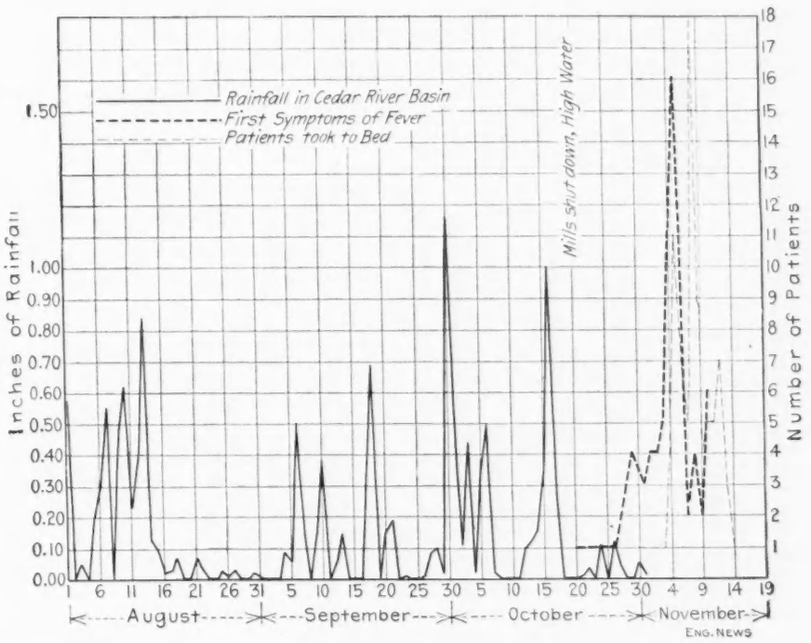
Thus it can be seen that there are many possibilities of contamination of the supply. The trap on the overflow pipe does not absolutely seal it against flood waters, and if it did, water might enter through the imperfect masonry walls of the springs or through the interconnected channels of adjacent springs; neither the wooden conduit nor the pump cistern can be considered watertight. Moreover, the creviced seamy condition of the limestone itself is favorable to the transmission of pollution. The general danger of pollution of ground water by infiltration has doubtless been greatly exaggerated by well meaning health officials and others in many parts of the country; indeed it is probable that many sources thoroughly protected against contamination by gravel, sand, or other efficient filtering media have been unjustly condemned. But the present case is not of that character. The low head of the

‡Eng. News, Vol. 51, pp. 126, 129, 302.

spring, coupled with its enormous discharge, the seamy creviced condition of the limestone wherever exposed, and the turbidity of the water coincident with floods and heavy rainfall, all point to the existence of well defined solution channels through which water might pass as through a pipe — that is, without any filtration whatever.

History of the Epidemic

The history of this outbreak shows features corroborating suspicion of the water supply. This is shown graphically by the accompanying curves. According to the records of the Weather Bureau stations in Cedar River basin above or near Cedar Falls, very little rain fell between the middle of August and the end of September. Heavy rains occurred Sept. 30 and the two days following. Heavy general precipitation took place again Oct. 14 to 17 and caused a 4.5-ft. rise of Cedar River that necessitated shutting down the mills at Cedar Falls on Oct. 19 and 20, and also covered the overflow pipe at the springs. The onset of the illness was about Nov. 4; it continued high till Nov. 8, and then gradually diminished. If 14 days are allowed for the incubation period, the date of infection was about Oct. 21, or immediately following the floods and heavy rains. Between Nov. 3 and 9, 51 patients took to their beds. The total number of cases is not known, but nearly 150 cases due to primary or secondary infection, and 16 deaths, occurred before Jan. 15, 1912. The close relationship between drought, rainfall, flood, and onset of the disease all point to infection of the water supply as the vehicle of infection.



Rainfall and Typhoid Curves at Cedar Falls, Iowa, August to November, 1911

Examination of the Water Supply

This case is specially noteworthy because it is one in which laboratory tests of the water have failed to arouse suspicion. Bacteriological examinations of several samples collected between Nov. 11 and Jan. 4, or some time after the probable date of infection, indicated contamination from surface sources at times, although most of the examinations gave no evidence of such contamination. Chemical analyses during four or five years have not resulted in condemnation of the water and the figures of the analyses would not logically have warranted condemnation. These features bring out forcibly the danger of depending on laboratory examinations alone to determine the potability or nonpotability of domestic supplies, and the futility of establishing so called "standards" for the interpretation of chemical analyses. The spring supply of Cedar Falls is possibly free from pollution much of the time. Heavy rainfall after a long drought, however, furnished the best possible conditions for an intense but temporary infection, a disaster that might be repeated and against which there is no protection. The epidemiological study points conclusively to the water supply as the cause of the trouble, and the sanitary survey reveals several opportunities for contamination. At best the results of chemical and bacteriological examinations of water should be regarded only as supplementary evidence and no chemist or bacteriologist should pronounce a supply safe to drink on the basis of a few laboratory tests.

Protective Measures

The spring supply is now being disinfected by means of calcium hypochlorite and the people have been warned to boil their drinking water. It has been recommended also that the sanitary sewerage system, already extensive, be developed to include greater areas and that the use of private cesspools be prohibited wherever connection can be made with sewers. It has been recommended that a new source of supply be obtained, either by filtering the water of Cedar River or by softening that from deep wells.

The Lock-Control Systems of the Panama Canal have been designed so that all apparatus will be put in operation from a raised central tower on the wall between duplicate locks. Incidentally, it is planned to make the operation proceed in a given order to prevent accident. Specifications for equipment in accordance with the description below have been forwarded to Washington and bids will be asked for.

Water is let into, or run out of, the lock chambers by culverts under the lock floors, these being connected with larger culverts in the walls and opened or closed by motor-driven, cylindrical valves. The center-wall culverts connect with lock chambers on both sides. The miter gates are never to be opened except after the water level has been equalized on both sides of them. Each gate leaf, valve and fender is operated by a separate motor in a machinery chamber in the lock wall. In each of these chambers will be a starting switchboard with remote-control contactors. Motors of less than 25 hp. capacity will be thrown directly on the line (220-volt 25-cycle) but the larger motor starters will have one approach point in each direction of rotation to insert resistance in the external circuit.

The contactors themselves will be operated by 220-volt alternating-current circuits leading to a house raised 16 ft. above the lower end of the upper flight and from which an uninterrupted view of every part of the lock is obtained. Here will be a control bench, 32 in. above the floor, holding a diagrammatic model of the lock, to show the opening and closing of the gates, the changing water level in the chambers, and the operation of the fenders and gates.

This control system will be interlocking so that the switches must be thrown in a given order; for instance, the gates at one end of the main conduit cannot be opened until those at the other end have been closed. This prevents the operator from passing water from one chamber to a third, past a middle one, and flooding a machinery room. A fender chain cannot be lowered until the miter gate it guards is open or has started to open. Valves cannot be opened a lock length above or below a miter gate which is being opened or closed. The valves controlling the openings into the twin-lock chambers from the center-wall conduit are interlocked so that one side or the other must be closed at all times, except when it is desired to cross-fill, and then they may be opened by special procedure.

The Panama Canal Electric Towing Locomotives

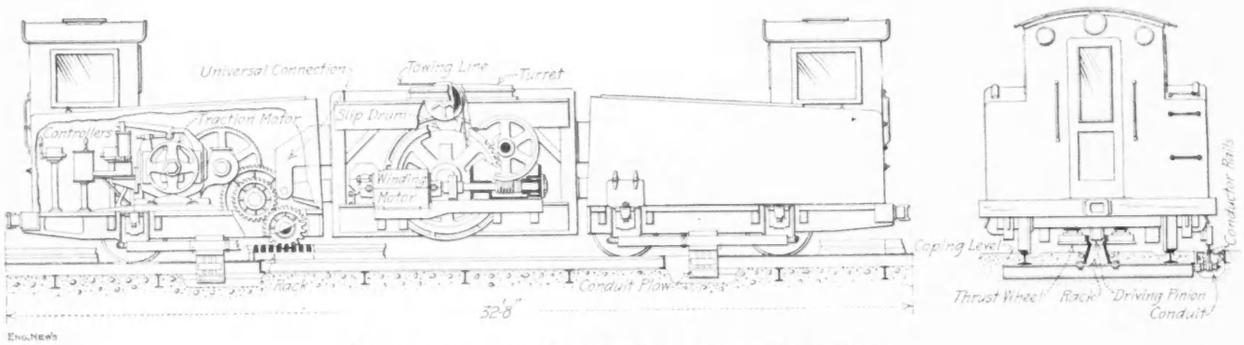
Award has recently been made to the General Electric Co. for the first of the Panama Canal electric towing locomotives. Provisional awards, dependent on satisfactory performance, go with this for 39 others, which will complete the locomotive equipment. The price bid for the 40 units was $498,016.

The Panama towing system has been devised and patented by Edward Schildhauer, of the Canal Commission engineering staff. Ships will be towed through the locks at a speed of two miles per hour by a locomotive forward on either side; there will also be a locomotive aft on each side of the vessel towed along the tracks to steady the boat. These locomotives will travel on a 5-ft.-gage track of 90-lb. rails laid on steel ties anchored in concrete. There will be a cast-steel center rack rail on all towing tracks. The center wall of the twin locks will carry two towing tracks with a return track between; each side wall will have one towing and one return track. All these tracks are level, except where there is an incline from one lock to another in the flight; here the grade is heavy and racks are used on all tracks. The maximum load on the traction motors comes in ascending these grades (done without tow-line load).

The locomotive will be made in three sections, as shown in the accompanying figure. Two four-wheel trucks will support a windlass frame between them on universal joints. The traction motors may be positively geared to the rack pinion and the locomotive will then attain a maximum speed of two miles per hour. For returning on the friction track, the motors may be thrown onto the wheels by toothed clutches in which case a speed of five miles per hour is attainable. Each truck will carry one three-phase 220-volt 25-cycle mill-type slip-ring induction motor, the two motors of each locomotive being operated in parallel and controlled by resistance in the rotor circuits. The locomotive may be operated from either end; there will be seven speed points in the control, for both directions, besides a coasting point (both brakes and power off). Drum brakes, electrically released, are shown on the motor shaft. Loss of current at any time throws the brake on and stops the locomotive; this scheme was adopted for safety in ascending the grades between locks. Horizontal thrust wheels are shown bearing on the sides of the center rack tail, to carry the side pull of the tow line.

The windlass frame will have an 18-in. drum, driven through a friction clutch, set to slip at 25,000 lb. tow-line tension. The drum will have two squirrel-cage induction motors, one of 7 hp. for hauling in the line under load at 10 ft. per min., and the other of 2 hp. for coiling the free tow line at 200 ft. per min. The tow line passes over a guide sheave fixed in a revolving turret, so that the line may always bear directly on this sheave.

The locomotive frame is made as light as possible since it does not depend on adhesion for traction. The 220-volt three-phase current is supplied through two contact rails in a side-track conduit, the track rails serving as the third conductor.



ELEVATIONS OF THE PANAMA CANAL TOWING LOCOMOTIVE

The Preservation of Natural Scenery is an unusual feature of contracts for engineering construction work, but is required in the contract for the Arthur Pass tunnel (5⅜ miles) now being driven for the New Zealand Government Railways. We quote the clause in question from the New Zealand contract:

> The works are situated in a national scenic reserve. The contractor shall carry out all his works in such a way as to cause no permanent disfigurements. Workmen or others connected with the works convicted of setting forest or bush or other vegetation on fire will be liable to immediate dismissal and to prosecution. Beyond the formation of the approach cutting at the Bealey end of the tunnel no works of any kind, except such as may form part of this contract, and no cutting of timber will be permitted on the hillsides on the left bank of the Bealey within 40 ch. of the tunnel mouth, both up and down stream.
>
> At the Otira end of the tunnel, no timber will be allowed to be cut from the forest for construction purposes, and only firewood from fallen or dead trees will be allowed to be used by the contractors or workmen as permitted by the Resident Engineer. In the Bealey valley, timber may be allowed to be cut in such restricted quantities and in such localities as shall be allowed by the Resident Engineer.

The Chicago River and the Chicago Harbor

A dual harbor and a distinct separation of facilities for through-freight shipping and local-freight shipping are the general principles of a harbor system for Chicago advocated by Lieut.-Col. George A. Zinn, U. S. A., in a paper read recently before the Western Society of Engineers. He would have a harbor for through-freight transhipment at some point outside of the city limits and convenient to a freight belt line, this point being either on the lake front, the drainage canal or the Calumet River. For the accommodation of the local freight water traffic, he would retain the present private docks at warehouses, railway freight sheds, etc., along the river, and supplement them by municipal docks (with warehouses, freight-handling machinery, etc.) at intervals. This same project is recommended in a report made by Col. Zinn to the Chief of Engineers, U. S. A.

Before going further into the description of Col. Zinn's project, we may say that after a period of controversy as to the relative merits of the river and the lake front for an improved harbor, the preponderance of opinion appears to be in favor of one general harbor on the lake front. This would limit the vessel traffic of the river to lighters and to boats destined for certain points on the river or the drainage canal. This location has been practically adopted as the recommendation of the Harbor Commission, and plans have been prepared for the first two of a set of five piers which are to extend from the lake shore north of the mouth of the Chicago River. These include a 3000-ft. pier for freight vessels and a 2300-ft. pier for passenger vessels. The City Council has appropriated $5,000,000 for harbor purposes, conditioned upon a new bond issue, and the plans now await its approval. The federal government has been requested to undertake the construction of an outer breakwater forming a protected area in front of the piers.

One great objection to the increased use of the river by large vessels is the

delay to street traffic caused by the opening of the numerous bridges, but Col. Zinn stated that this is not so great as is generally supposed. He gave the average period of the open draw as 3.6 min., with an average of 10 to 20 openings per 24 hours at different bridges. At present the city limits the opening of the bridges to certain hours, to avoid undue interference with the rush-hour traffic, but free use of the river would involve the removal of this limitation. Col. Zinn appears to minimize the difficulties of operating large vessels in the Chicago River. He makes no reference to the necessarily slow movement of a vessel in a narrow waterway obstructed by numerous bridges, the difficulties of handling vessels under such conditions without the expensive assistance of tugs, or the liability of injury to bridges and vessels under these conditions (as when a bridge opening is delayed a few seconds and the ship has the alternative of striking the bridge or swerving to the abutment).

We give below a brief abstract of Col. Zinn's paper:

PLANS FOR WATER TERMINALS AT CHICAGO

The outer harbor, and the Chicago River from its mouth to Belmont Ave. on the north and Robey St. on the south, now have (or soon will have) a depth of 21 ft. The main river and the south branch to Robey St. are (or soon will be) 200 ft. wide. The North Branch has a width varying from 120 ft. to 180 ft. The entire river is obstructed at various points by center-pier bridges; these, however, will be replaced within a few years by single-span bascule or lift bridges, the spans varying from 140 ft. to 200 ft. When the improvements now in progress are completed, it will be possible for all lake carriers (with the exception of a few) to pass from the lake to Robey St., and for all moderate-sized vessels to go north as far as Belmont Ave.

Lines of vessels carrying bulk and package freight are operated between Chicago and points on the Great Lakes. Bulk freight is delivered on the Chicago and Calumet rivers. Package freight is moved on the Chicago River from point to point by lighters. Bulk freight is generally consigned to a single point, and the entire cargo removed from the vessel at that point. The vessels of the regular lines make several landings in the Chicago River for the purpose of collecting and delivering package freight at railway-owned docks, private warehouses, and elevators. Vessel lines, owned or controlled by railway corporations, handle practically all of the package-freight business over railway-owned docks. The local trade in fruit and passenger traffic is carried on at docks located near the mouth of the Chicago River.

The total receipts and shipments of bulk freight by water at Chicago in 1910 were 2,877,948 tons. The total estimated tonnage of package freight for 1910 is 2,363,000 tons, of which about 100,000 tons is local. About 500,000 tons of stone are brought by water annually to Chicago from points on the Sanitary Canal. Grain to the amount of 500,000 bushels annually is moved from one point to another on the Chicago River. The city garbage department and private disposal stations handle 556,000 tons of material annually on the river. About 50,000 tons of coal annually are handled in barges. The two lighterage companies move about 100,000 tons annually. Sand and other materials moved on the river amounted to several hundred thousand tons.

Considered as lines of transportation, Chicago's waterways are not congested, except in the Chicago River near its mouth, where are located the docks of all vessel lines carrying on a trade in local freight. The real cause of this congestion is not the narrow channel nor the great quantity of business handled on Chicago's waterways, but in those more remote circumstances which induce the local freight lines to occupy docks near the mouth of the river.

The minor impediments to free navigation on the Chicago River can and should be removed. These are insufficient depth and width, bends in channel, current, center-pier bridges, lack of turning basins, closed bridge hours, towing charges imposed by local ordinances. All of these can readily be removed at a reasonable expense.

SEPARATION OF THROUGH AND LOCAL FREIGHT—Present conditions show a congestion of street traffic, a congestion of rail traffic within the city limits, and a congestion of river traffic near the mouth of the river. Freight movement by water is controlled by the railway lines, through rail freight is carried into and out of the city, through rail and water freight is carried into and through individual city railway and vessel terminals. There are no public docks and warehouses on the waterways for the receipt and shipment of local freight by water. City ordinances and physical impediments hamper the free movement of vessels in the Chicago River and other waterways.

Chicago business interests can derive but little benefit from the movement of freight having its origin and destination outside the city. Such freight entering the city only adds to the congestion of streets, warehouses, railway tracks, and waterways. Transfer between one rail line and another, or between a rail line and a water line, should take place, therefore, beyond the limits of railway congestion. The railways propose to secure relief by the construction of a belt line (uniting all of the railways), within which no through freight shall pass. Does it not follow that the water transportation lines must unite with the railways in the enterprise, exclude from the city their through freight, and trans-ship it at a point [termed a commercial harbor] located on or near the same belt line.

The objection may be made that vessels as a rule carry both local and through freight, and, therefore, two landings would be required, one at the commercial harbor and one in the Chicago River, instead of one (as at present) at the latter locality. In reply to this, it need only be stated that under present conditions, several landings are necessarily made by package-freight vessels entering the river; and, in fact, through freight now delivered at several landings in the river would all be delivered at a single landing in the commercial harbor.

The economical movement of local freight seeking water transportation requires that suitable terminal facilities should be provided at points on all of the waterways where density of traffic warrants it. If we assume a certain distance as the limit of economical team haul, twice this distance will represent the proper spacing between terminals on the waterfront. It may be safely said that such facilities should be provided along the Chicago River at intervals of about 1½ miles, that they should be provided at one or more places on the Calumet River, and that they are not now required along the lake front of the city of Chicago. These facilities (consisting of docks, warehouses, machinery, etc., for the handling of package and bulk freight) cannot be provided by water-transportation lines economically and must, therefore, be provided by the municipality. Consignments of bulk freight in entire cargoes will, as heretofore, seek the privately owned consignees' dock. To impose the necessity for trans-shipping such cargoes would eliminate the advantage of water transportation.

BRIDGES AND TUNNELS—The exclusion of through freight from the river, the distribution of local terminal facilities along the river, instead of their concentration near its mouth, will relieve street and railway congestion within the city limits.

It may be said that the transportation of local freight in the river will seriously inconvenience passenger and team traffic in the streets by the frequent opening of draw-bridges. It has been shown that the delays occasioned to street traffic by open bridges during 24 hours are not serious, but the advantages of extensive water-transportation facilities to the business interests of Chicago are so great that a solution of the difficulty can be found in the construction of street tunnels under the river at advantageous points. The completion of the proposed passenger subway will remove practically all complaint against open draw-bridges.

CONCLUSIONS—The plan suggested provides terminal facilities for the handling and trans-shipment of waterborne freight by (1) a single terminal for through freight located at a distance from the business center of the city and (2) a

number of terminals within the business district for local freight. This is similar to the plan proposed by the Barge Canal Terminal Commission of the State of New York for handling the traffic of the new barge canal at New York Harbor.

A lake-front harbor within the city limits will be a most unsuitable place for the transfer of through lake and rail freight, because it is impossible for all the railways to reach it and even difficult for one railway to reach it with suitable trackage, and because in no way will it relieve the present congested condition of railway freight movement. As a place for the receipt and shipment of local freight, it can have no usefulness except for a limited area within economical team or lighterage haul. The long team haul, or the transfer to rail and subsequent team delivery required, utterly discredits it as a place for the shipment and receipt of the entire local freight movement of the city. The use of lighters in connection with such a harbor is analogous to team delivery, the lighter having a much more limited sphere of usefulness than the team, although much cheaper for a long haul.

One of the real causes in the diminution of Chicago's waterborne traffic is the control now exercised over that traffic by the railway lines, and not the lack of harbor facilities. The construction of a harbor will in no wise alter this condition of affairs, and without railway coöperation, given willingly or unwillingly, no harbor, however modern or well supplied with terminal facilities, can be a success for the transfer of through freight.

Statistics of Wooden Poles—The total number of poles purchased in the United States in 1910 was 3,870,700. This is the largest total ever recorded. About two-thirds of the total were cedar poles, and half the remainder were chestnut. The supply comes chiefly from three sections of the country; northern white cedar from the Lake states, red cedar from the Northwest, and southern white cedar mainly from North Carolina, Virginia, and New Jersey. The Northeastern states furnish most of the chestnut poles. The purchase of cypress poles is falling off and the use of Douglas fir in the Northwest is increasing. About three-quarters of the poles are sold to telephone and telegraph companies.

The number of treated poles was about 825,000, or 21.3% of the total. This was an increase of 248,000 over the number treated in 1909. By far the larger part of the treated poles were treated after purchase. The electric railway and power companies have been especially active in pole preservation. Although the number of treated poles reported is growing rapidly each year, most of these poles receive merely a superficial treatment which adds only a few years' service. The increase in the practice of really effective pole preservation has been retarded by the lack of pole-treating apparatus applicable to the needs of the small consumer. The usual method is that of merely painting the lower end of the pole with the preservative.

Annual Conventions of Brick and Clay Manufacturing Interests

The annual conventions of several associations connected with the brick and clay manufacturing industries were held at Chicago during the week ending Mar. 9. The associations included the following: The National Brick Manufacturers' Association, the National Paving Brick Manufacturers' Association, the Building Brick Association of America, the American Ceramic Society, the National Clay Machinery Association, and the Illinois Clay Manufacturers' Association. The total registration of members and visitors was nearly 700. In view of the energy and interest displayed by Chicago representatives in getting up the first Clay Products Exhibition, it was decided to hold the next convention at Chicago also, in 1913.

National Brick Manufacturers' Association

This is the main association, to which the others are auxiliary, and a considerable proportion of the time of its meetings was devoted to discussing the condition of the brick industry and means for its improvement. The discussion related largely to the very serious competition of concrete and reinforced-concrete construction which has in many ways resulted adversely to the brick interests. Unfortunately, a part of the discussion took the form of merely derogatory remarks, the speakers being unable to realize that there is a field for concrete as well as brick, and that there are good concrete structures as well as good brick structures. That brick is not such a universally perfect product as some of the enthusiastic and eulogistic speeches might indicate, was shown by the statements of some manufacturers in a discussion at a meeting of the Illinois Clay Manufacturers' Association. It was stated flatly that one reason for unsatisfactory conditions in the brick trade is that the market is flooded with poor brick, which must be sold for what they will fetch, and which thus injure the business by competing with good brick which cannot be sold at such prices, except at a loss.

The general trend of the discussion first mentioned, however, was in favor of a strong campaign of publicity in order to inform property owners, architects, engineers, builders, contractors and others as to the advantages and possibilities of brick as a modern material of construction. This was the main purport of a paper by J. B. Rose (Roseton, N. Y.) on "Back to Brick," in which he advocated raising a fund of $100,000 for such a campaign. Among other matters, he stated that not long ago the City of New York called for bids on 21 fire department houses of concrete construction, costing $7000 to $13,000 each. The brick interests succeeded in persuading the Fire Commissioner to call for bids on both concrete and brick construction, with the result that (according to Mr. Rose) the latter was adopted and saved an aggregate of $180,000 over the estimated cost for concrete construction. He stated also that as a result of the representations of the brick interests, one part of the New York subway system which had been designed for concrete has been re-designed for brick construction.

The relation of technical education to the clay industry was one of the subjects presented, the secretary opening this with a paper by Dwight F. Farnham (Seattle, Wash.). A question was raised as to the ability of a college graduate to cope with the rough work and every-day conditions of a clay-working plant; in reply to this, Prof. R. C. Purdy (Columbus, Ohio) stated that it was his practice to copy these conditions as far as practicable and to teach the boys to think for themselves instead of coming to him as soon as a difficulty or emergency was encountered. He gave instances of several students who had made a success of their work in commercial plants. At a meeting of the Illinois Clay Manufacturers' Association also, the value of technical education was endorsed by managers of plants as well as by Profs. Purdy, Orton and Bleininger.

An interesting paper on "Relative Economy and Efficiency of Power Trucks and Horse Haulage," by A. R. Warner (Cleveland, Ohio), was illustrated by numerous lantern slides of motor trucks of ½ ton to 5 tons capacity in use by dealers in brick and building supplies. It was shown that the highest efficiency and economy are reached when there is business enough to keep a motor truck in constant use. It was stated also that one firm uses such trucks for deliveries up to a distance of 70 miles, and can guarantee delivery on the job in one day, since it avoids the delays and rehandling incident to shipping by rail.

A paper on "Steam and Electric Power for the Operation of Brick Yards," by Louis Campbell (Grand Forks, N. D.), brought out some commendation for the electric system where power can be purchased, but the generation of power at the brick plant did not receive much favor. In any case, steam is required for the driers and other parts of the plant.

Investigations as to the relation of the porosity of bricks to their crushing strength were reviewed briefly by Prof. A. V. Bleininger (Univ. of Illinois), who also presented before the Illinois Clay Manufacturers' Association papers on the Illinois coal-measure shales and the work of the ceramics department of the University of Illinois. A few papers related to clay-working machinery, and others related to the subjects of paving and build-

ing; these latter are noted below under their respective headings. The election of officers resulted as follows: President, C. A. Bloomfield, Metuchen, N. J.; secretary, T. A. Randall, Indianapolis, Ind.

Brick for Paving

The meetings of the National Paving Brick Manufacturers' Association related mainly to business affairs. The association has for some years conducted a campaign not only of publicity, but of education, it being to the interests of the manufacturers to insure that proper work is done where their material is used. For this purpose it has distributed quantities of special literature for the information of engineers, contractors, public officials, business men, and taxpayers in general. It has also done good work in improving the quality of paving brick. The president is Charles J. Deckman, Cleveland, Ohio, and the secretary, Will P. Blair, Cleveland, Ohio (both reëlected).

In its specifications for brick paving, the association is committed to the use of cement grout filler, and it takes the strong stand that "soft" (or bituminous) fillers are not adapted to insure the best character of brick pavement. This stand was emphasized by the president, Mr. Deckman, in his address. It is intended to appoint an engineer to the staff of the association. The annual report of the secretary, Mr. Blair, reviewed the publicity work of the past year; this included the preparation and distribution of pamphlets and specifications, lecturing on the advantages of brick paving for streets and roads, and holding conferences with local authorities and engineers and technical associations.

Reference was made to the fact that at Detroit, brick had suffered through a controversy between public officers as to the quality of brick purchased. At Chicago the use of brick declined 90% in about eight years (or from 10,000,000 a year to 1,000,000); this has been due in part to unsatisfactory methods of construction, resulting in defective pavement. It is such conditions as these that the association has to encounter in its campaign for increasing the use of brick. It is estimated that the output of paving brick for 1911 was equivalent to 6,000,000 sq.yd. of pavement.

It was suggested that the use of brick paving for country roads would be assisted if the association should establish standards of brick for pavements suitable for heavy, medium and light traffic; also that the rattler tests for such brick should provide a maximum loss of 22, 26 and 28%, respectively. These are the figures provided for by the American Society of Testing Materials, and after discussion it was considered that this was sufficient without action by the association.

One question brought up was as to the desirability of preparing specifications for second-class brick. It seems that in Ohio there has been a suggestion to use this material on country highways, for which it is claimed to be quite as good as first-class brick, besides being cheaper. A form of specifications prepared by a state highway commissioner was read, and discussion or criticism of this was invited; the specifications outlined the permissible defects or flaws and required a loss not exceeding 25% in the rattler test. Some members thought that to officially recognize second-class or defective brick would injure the reputation of brick as a first-class paving material. Eventually it was held that as the question affects the Ohio manufacturers only, it should not be taken up by the national association. At the meeting of the Illinois Clay Products Association there was a general discussion on the good-roads movement in Illinois, with particular application to the use of brick for roads. The discussion favored the state-aid system, and the passage of laws making it possible to provide money and means for improved highway construction. Very little was said, however, as to the actual use of brick, except that its use would involve lower maintenance expense than the use of macadam.

Brick for Building

The Building Brick Association of America is an organization of manufacturers of face brick, its purpose being to promote the use of brick in building construction. It held a public session, at which a number of papers were read as to publicity methods and methods of working in combination. Judging by some of the papers, the brick business has been injured by destructive competition, in which the object seems to be not so much to get an order as to prevent a competitor from getting it. Thus the papers on "constructive competition" and "industrial coöperation" seemed to be peculiarly appropriate. The officers elected include Ralph Simpkins, president, and J. Parker B. Fiske, secretary.

There were no technical subjects presented, except that reference was made to the present movement for extending the fire limits of Chicago. An objection urged against this is the increased cost of small dwellings occupied by wage-earners; this point has been referred to architects, however, who reported that on cottages costing $3000 to $5000, the increased cost over frame construction would be only 8 to 9% in common brick and 12% in hard brick. On the other hand, the brick buildings would be safer and more permanent, and consequently would reduce the fire loss of life and property and the expense for fire-protection equipment on the part of the city. The association, of course, favors brick not only for the smaller class of dwellings, but for high-class residences and business buildings.

In a paper presented before the National Brick Manufacturers' Association, W. C. Denison (Cleveland, Ohio) advised makers of common brick to go into the business of making hollow tile for building construction. He showed that this system of construction is increasing rapidly, in buildings of various classes, and is being used by a large number of leading architects. He referred also to articles in Engineering News speaking favorably of hollow-tile construction for buildings. Mr. Bloomfield remarked that not all clays can be used for such tile.

Drain Tile

The drain-tile industry is proposing to follow the lead of the brick industry in organizing a general association of tile manufacturers and in starting a campaign of publicity to improve its business and enlarge its field. The subject was opened by J. W. Anderson (Woodland, Ill.) in a paper before the National Brick Association on "The Need of Organization among Drain Tile Manufacturers." Later the subject was discussed at greater length at a meeting of the Illinois Clay Manufacturers' Association, but in a general way and with a somewhat indefinite aim. Reference was made to the competition with cement or concrete tile, which latter material was spoken of with great disfavor, as might be expected. Very little was said as to tile drainage, but the general subject of land reclamation by drainage (both ditch and tile) was presented in a paper by Jesse Low (Beardstown, Ill.) relating particularly to the recent movement to secure the participation of the federal government in this class of reclamation work.

Two Important Bridge Projects are now under way to provide additional railway connections across the Ohio and Mississippi Rivers. The Kentucky & Illinois Bridge Co. has been organized to build a double-track bridge over the Ohio River, a few miles below Paducah, Ky., at an estimated cost of $3,600,000, or $4,500,000 including approaches. The company represents four railway systems which will use this bridge: the Chicago & Eastern Illinois R.R. (St. L. & S. F. Ry. System), the Chicago, Burlington & Quincy R.R., the Illinois Central R.R., and the Louisville & Nashville R.R. This bridge project has received an impetus from the increase in north and south traffic, which is expected to accompany the opening of the Panama Canal, so that additional facilities are required for present and prospective routes between northern centers and the Gulf ports. The second bridge project is that of the Memphis & Arkansas Railway Bridge & Terminal Co. which was organized to build a bridge over the Mississippi River in the neighborhood of Memphis, Tenn., in the interests of the Chicago, Rock Island & Pacific Ry. system. The project includes extensive freight yards and terminals adjacent to the bridge. The cost of the bridge and other improvements is estimated at $5,000,000. W. S. Tinsman, of Chicago, is president of this company.

Electrolytic Sewage Treatment

By Howard V. Hinckley*

The sewage of a part of Oklahoma City, Okla., is being treated by reagents produced by electrolysis. Bacterial reports and operating costs are given. Following Mr. Hinckley's article is a staff review of twenty-five years' attempts to use electricity in the purification of water and sewage. An editorial discussion on the same subject, with comments on the Oklahoma City plant, also appears in this issue.

*Consulting engineer, Oklahoma City, Okla.

In the fall of 1910, A. J. McMahan, of Oklahoma City, Okla., offered to install an electrolytic sewage-treating plant to take care of the effluent from a septic tank that had previously been constructed a mile north of the north limits of Oklahoma City; to guarantee certain results and to give the city a six months' test. On Nov. 4, 1910, his proposition was accepted and on March 29, 1911, the plant was put in operation. The provisions of the guarantee,* as stated in the contract between Mr. McMahan and the city, dated Nov. 4, 1910, were as follows:

(1) The plant shall have ample capacity, when all units are in operation, to successfully treat 750,000 gal. of sewage each 24 hours.

(2) The effluent shall be practically neutral and free from odor after the gases liberated by the treatment have had time to escape.

(3) The effluent shall be free from disease germs and may be discharged into the creek without giving offense or endangering the health of the public.

(4) The effluent shall not undergo secondary putrefaction under any climatic conditions.

(5) The cost of electric current for operating the plant shall not exceed $750 per annum, provided that the cost of current shall not exceed 5c. per kw.-hour.

It may be stated, in passing, that under license with the Electro-Sanitation Co., of Los Angeles, Calif., Mr. McMahan controls certain electrolytic patent rights in the states of Kansas, Oklahoma and Texas. Also, that the Oklahoma City plant was put in upon the recommendation and under the supervision of W. C. Burke, then city engineer of Oklahoma City, with L. G. Lautzenhiser, of Los Angeles, as superintendent of construction. Mr. Lautzenhiser is general manager of the company, holding the electrolytic patents, and is himself one of the patentees.

Description of Plant

The plant (Figs. 1 and 2) consists of a concrete-block house, 18x50 ft. in plan, in which are three treating flumes, each 18x22 in. in cross-section and 30 ft. in length, made of 2-in. plank held together by bolts and strapped across the top every 6 ft. In each of the flumes there are ten sets of cast-iron electrode plates, each set consisting of 27 plates, ⅜x10x24 in., capped with copper. The rated capacity of each of the three flumes is 250,000 gal., or 25,000 gal. of sewage per 24 hours for each electrode set. The concrete floor has a fall of 1 in. The flumes have the same fall and rest on 6x6x26-in. blocks. The electrode sets, including plates, bolts, insulator bushings and hangers, are detachable and interchangeable. Baffles of sheet metal, hinged on small cross rods, rest upon the bottom of the flume and prevent any straggling microbes from sneaking along the floor of the flume under the plates. A similar gate at the foot of each flume provides means of washing out, during which time the baffles are raised. Vertical baffles of similar construction are affixed to the sides of the flumes.

*The contractor wishes it understood that the guarantees entered into here are not to be taken as an expression of willingness to duplicate them elsewhere, any more than guarantees are given for results to be obtained by septic tanks.

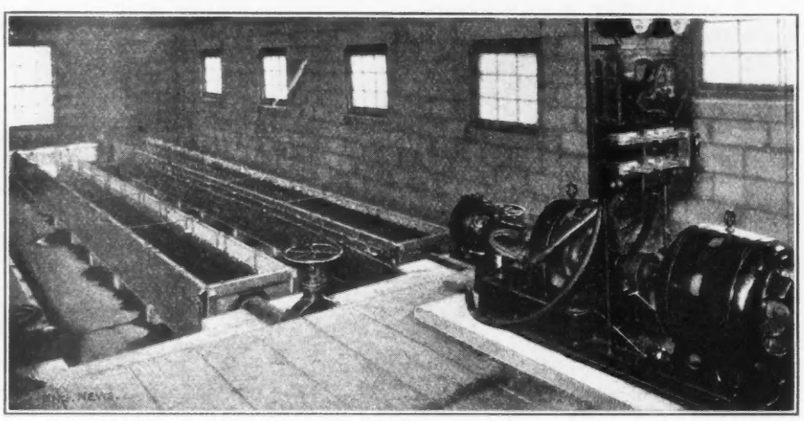


Fig. 1. Interior of Sewage-treatment Plant, Oklahoma City, Okla., Showing Electrode Flumes, Electric Motor and Generator

In the upper end of the house, on a lumber floor, level with the tops of the flumes, is placed the operating machinery, which consists of a 7½-hp. alternating-current motor, using commercial current at 220 volts, driving a 3-kw. multipolar direct-current generator and exciter, all three on one shaft and resting on a 2x5-ft. bedplate. The switchboard straddles the shaft between the motor and the generator. The generator is of special construction for this service and delivers high amperage at low voltage. Copper conductors of 1,000,000 circ. mils. take the current through knife switches at the head of each flume to the copper busbars on the side of each flume. These, in turn, tap onto the hangers that hold the electrodes, one hanger feeding 14 plates through the supporting rod at the end of the set, and the other hanger handling the negative or return current. The two intermediate packing rods are insulated with rubber.

A reservoir, holding 36,000 gal., collects the night flow at present and is designed to eventually equalize the flow to the flumes whenever the plant is operated 24 hours per day. From this reservoir each flume has its independent 8-in. supply pipe passing under the operating floor, with a gate valve at the upper end of the flume.

Method of Operation

The valves are opened, commercial current is turned onto the motor, the ammeter is set at 270 per flume, and the sewage in the flumes becomes milky with minute bubbles generated by the current of 1½ to 3 volts as it cuts the water into its two gases and liberates chlorine from the sewage. Iron and copper are dissolved and become powerful reagents and effective coagulents. Other chemical changes take place, but the three nascent gases are the main purifiers. The surface is covered with white foam of gases, and this foam tumbles with the effluent down into the gulch below the plant.

Change of Policy—Two years ago, the septic tank was built at a cost of $8000, and later, when bids were opened for contact beds to purify the septic effluent, the lowest bid was $17,000. It was then that the Electro-Sanitation Co., of Los Angeles (through Mr. McMahan), secured the acceptance of a proposition to install an electrolytic plant to treat the septic effluent, the plant to be tested for six months under guarantee. The price

to be paid was $12,000. After two months' trial a bypass was built around the septic tank, as it was found much more satisfactory to treat the fresh sewage than the septic effluent. The septic tank is now out of commission, except that the two small grit chambers are used to catch the coarser matter.

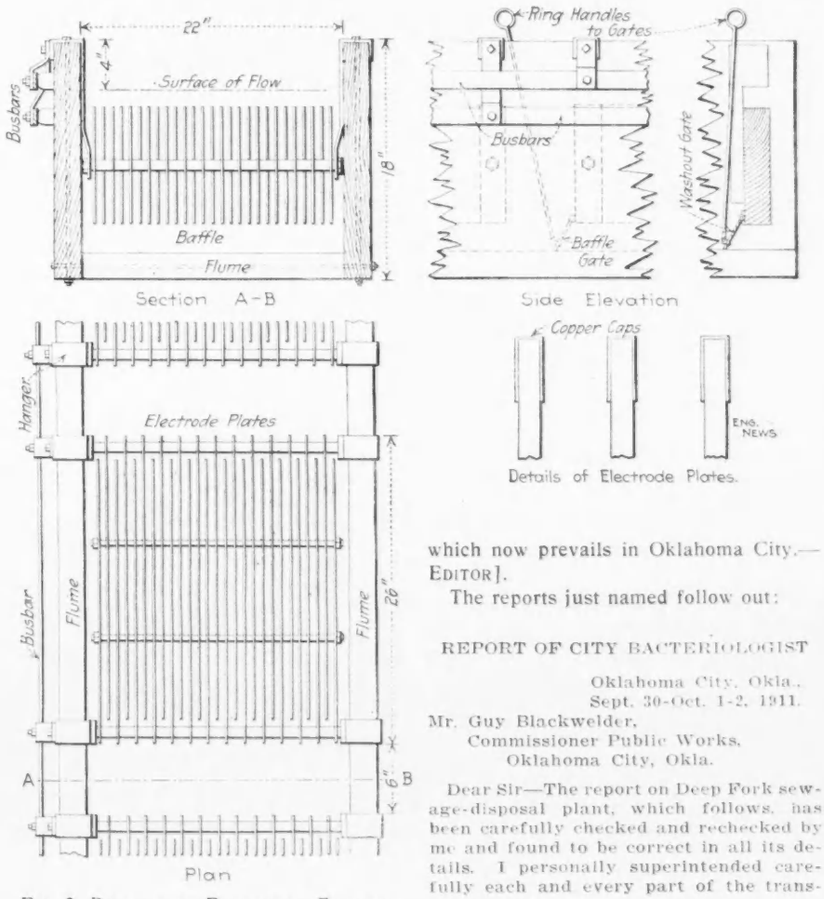


FIG. 2. DETAILS OF ELECTRODE FLUMES, SEWAGE-TREATMENT PLANT, OKLAHOMA CITY, OKLA.

GENERAL RESULTS—Thus far, only two of the flumes, with their electrodes, have been used.

Only a minor percentage of the solids are removed in the grit chamber. All the finer particles are amply sterilized by the oxidization process in the flumes. After six months of operation of the plant there is no odor in the dry gulch, in spite of the fact that the grit chambers (and previously the septic tank) have been emptied and washed out into the gulch at intervals. The run of over a mile from the city limits to the plant is helpful in breaking up the solids.

ACCEPTANCE TESTS

The contract did not prescribe who should make the acceptance tests.

For his own information, Mr. McMahan made many methylene blue tests, to determine the stability of the effluent. The only official test in behalf of the city was a series of bacterial examinations made by the City Bacteriologist. Similar tests in behalf of the contractor were made by the State Bacteriologist. A report on the plant was also made by the Commissioner of Public Works [one of the five city commissioners under the commission plan, which now prevails in Oklahoma City.—EDITOR].

The reports just named follow out:

REPORT OF CITY BACTERIOLOGIST

Oklahoma City, Okla.,
Sept. 30-Oct. 1-2, 1911.

Mr. Guy Blackwelder,
Commissioner Public Works,
Oklahoma City, Okla.

Dear Sir—The report on Deep Fork sewage-disposal plant, which follows, has been carefully checked and rechecked by me and found to be correct in all its details. I personally superintended carefully each and every part of the transaction.

Inspection—A markedly appreciable difference in odor was at once to be noted as regards the material at the intake and that at the lower end of tanks Nos. I and II.

The appearance of material was noticeably changed: that at the upper end having a marked milky turbidity. At the lower ends of tanks Nos. I and II, being only slightly turbid on account of portions of papers, etc. The odor being markedly changed was the most noticeable feature.

Below the tanks, and long before the material had reached the creek, the outflow was clear and quite limpid, and distinctly free from odor.

The findings bacteriologically were as follows:

Note—Standard (10 c.c. diameter) Petri plates used in all tests for bacterial growths in all the following reports.

I. Untreated material just above intake for tanks, showed 640,000,000 colonies per cu.c. Dilution, 1 — 100,000.

II. (a) Lower end Tank No. I:
Bacteria and cocci..... 157
Fungiform types 41
Total 198
1,570,000 colonies per c.c. Reduction, 99.75%. Dilution, 1 — 10,000.

(b) Lower end Tank No. II:
Bacteria and cocci..... 113
Fungiform types 97
Total 210
1,130,000 colonies per c.c. Reduction, 99.82%. Dilution, 1 — 10,000.

III. Twenty (20) ft. below end of Tanks Nos. I and II:
Bacteria and cocci..... 108
Fungiform types 112
Total 220
1,080,000 colonies per c.c. Reduction, 99.83%. Dilution, 1 — 10,000.

It is a noteworthy fact that, after leaving the plant, the number of germs relatively decreases and the ordinary algæ, which do not seem to be affected in the least by electrolysis, relatively and rapidly increase. (Vide supra).

I find from my examinations that those germs that are not killed by this process are so markedly inhibited that they are easily cared for by the ordinary algæ found in all surface waters. In proportion to dilution with surface water, consequently increased admixture with ordinary algæ, exposure to air and sunlight, the objectionable features are rapidly removed in proportion to distance from plant.

The findings here (20 ft. below plant) correspond to those several thousand feet below, in a small stream, in untreated material.

(Signed) Clarence Edward Lee,
Municipal Bacteriologist,
Oklahoma City.

REPORT OF STATE BACTERIOLOGIST

Norman, Okla., Oct. 2, 1911.

Mr. A. J. McMahan,
Oklahoma City, Okla.

Dear Sir—The analyses for total and contaminating bacteria of the samples of treated and untreated sewage from the Deep Fork electrolytic sewage-disposal plant are shown by the accompanying table.

The exact number of B. Typhosus could not be determined, but it is fair to presume that the percentage of reduction is as great as the reduction of other disease bacteria.

By disease bacteria I mean, Bacillus Typhosus, Bacillus Coli, Streptococci, Pyocyaneus, etc.

(Signed) Louis A. Turley,
State Bacteriologist.

BACTERIAL COUNTS OF CRUDE AND TREATED SEWAGE, OKLAHOMA CITY, OKLA.

		Treated Sample from		
	Untreated Sample from Intake	Trough No. 1	Trough No. 2	Spillway 20 Feet from Troughs
Bacteria per c.c.	1,300,000	174,000	164,000	98,000
Bacillus Coli	12,000	110	100	85
B. Typhosus	Present	Present	Present	Present
Streptococci	1,000	80	96	40
Reduction total bacteria, %	...	86	88	92.5
Reduction disease bacteria, %	...	98.5	98.4	99

Report of Commission of Public Works

Herewith submit the report of Dr. C. Edward Lee, city bacteriologist, relative to the number of disease germs in the effluent after treatment by the electrolytic method at the Deep Fork plant, and in supplementing his report, which is purely technical, will say that he informs me that the water after it leaves the plant is no more contaminated than ordinary surface water, and while he would not recommend it for bottling for drinking water, it is soon aërated and all disease germs destroyed, that are not totally disabled by the electricity.

He further states that all of the offensive odor is entirely removed, and in fact he considers this method of sewage treatment the best of any he has investigated.

As to the ability of the plant to treat 750,000 gal. per day, I herewith submit the report of J. E. Goss, Jr., cashier of the water department, who measured the amount of water passing through the two tanks now installed, and he estimates that the capacity is somewhat in excess of the estimated capacity, or 814,000 gal., with a 2-in. flow [over footboards—H. V. H.], while the company claims that it is possible to increase the flow to 3 in. and still get good results.

I have taken the amount of the bills paid for electricity during the time since the plant has been running and I find this amount to be an average of $1.25 per day, or $456.25 per annum. This, however, is hardly a fair estimate, as the treatment does not contemplate the operation of one or two tanks for its greatest economy, as all three troughs are to be operated by the same machine and the motor can be driven for operating all the troughs, practically for the same money that it can be to operate one.

(Signed) Guy E. Blackwelder,
Commissioner of Public Works.

Oklahoma City,
Oct. 10, 1911.

First and Yearly Costs

In order to get this plant installed for purposes of demonstration, the schedule price of $20,000 per 1,000,000 gal. daily capacity was cut by 20 per cent., making the contract price for 750,000 gal. daily capacity $12,000. Assuming an investment charge of $16,000 ($1000 for residence for attendance, and $15,000 as the price which any other city would be required to pay for a plant of this capacity), the yearly and unit costs for electrolytic sewage treatment at this plant are estimated as follows:

For	Per annum	Per million gal.	Per thousand gal., cents
Electric current	$ 709.50	$2.59	0.259
Attendant	660.00	2.41	0.241
Lights	40.00	0.15	0.015
Total operati'g	$1409.50	$5.15	0.515
Renewal of plates	200.00	0.73	0.073
Depreciation	100.00	0.37	0.037
Interest at 5%*	800.00	2.92	0.292
	$2509.50	$9.17	0.917

*The cost of the plant was met by a 5%, 20-year bond issue. Under the laws of the state, $1000 per year must be paid into a sinking fund. [It will be noted that this adds approximately 40% to the total annual burden on the city caused by the plant, making the cost $12.81 per 1,000,000 gal. if both depreciation and sinking fund are taken into account.—Editor].

Acceptance

Deep Fork Plant (No. 1) was accepted in October, 1911, by a unanimous vote of the City Commissioners, who went into office under a new charter form of government after the award of the contract for the plant.

Packingtown Plant (No. 2) to treat 2,250,000 gal. a day from the packing-house district and capitol Hill is now under construction and will cost about $46,500. In this plant the sewage will be raised 20 ft. or more for treatment by electric-driven centrifugal pumps, which will also serve to break up the solids. It is expected that the small amount of coarse, foreign matter which needs to be removed will be screened out, and that it will be subsequently destroyed in gas-burning incinerators, located in a screen room over a reservoir.

A Review of Attempts to Use Electricity in Sewage and Water Purification

The immediately preceding article on sewage treatment by electrolytically produced reagents at Oklahoma City, Okla., has led us to prepare the following review of the various attempts made during the past twenty-five years to purify water and sewage by the more or less direct use of electricity. Editorial comments on this subject are also presented in this issue.

Since the late eighties of the last century, Webster of England, Hermite of France and Woolf and Harris of America, to name the most prominent workers in the field, have tried to use electricity in the way just indicated. Although Webster was first in the field, we shall consider his efforts after a brief review of those of Woolf and Hermite, because the Harris Process, stripped of its early tomfoolery, is so like the Webster that the two should be described together. In the course of our review, brief mention of other processes will be made. The use of ozone and of ultra-violet radiation (see editorial for mention of ozone) will not be discussed here. (See Eng. News., Apr. 28, 1910, pp. 488 and 497; Sept. 15, 1910, pp. 275 and 283; Dec. 8, 1910, p. 633; Aug. 24, 1911, p. 220; Dec. 28, 1911, p. 783.)

Both Woolf and Hermite produced hypochlorite of sodium from either sea water or a solution of common salt, according to local conditions. Whether one copied from the other and if so which, or both copied from Webster, we cannot say; but in so far as either was a pioneer it was chiefly in the adaptation of an old process to a new purpose, with variation in details.

So far as we can learn, the Hermite process has never been used continuously for treating town sewage anywhere except at Ipswich, England, where, after ten years' use, it was abandoned in 1905, "on the ground that the results obtained did not warrant the expenditure" (Moore and Sillcock's "Sanitary Engineering," edition of 1909, p. 624). The liquid agent at Ipswich was "turned into the head of the main sewer," instead of being applied at the outfall. The Hermite system seems to have utterly failed to compete with other methods of sewage treatment, although tried at a number of places in both France and England, and made the subject of investigation by a *Lancet* (London) commission and of reports by other scientific investigators.*

Woolf came to the front in 1893, at a time when there was considerable popular agitation over the tastes and odors in the Croton water supply of New York City, and when an official campaign was in progress against minor local sources of pollution in the drainage area. Besides manufacturing and selling a commercial deodorizer and disinfectant called "electrozone," he vigorously promoted for a time the use of the same or a similar agent for the treatment of sewage and water. A small electrozone plant was built by the City of New York, at Brewsters, and a much larger one by the city of Danbury, Conn., both to treat sewage. The Danbury plant was soon abandoned, as stated in the accompanying foot note, which also mentions other instances of the use of electrozone in the United States, Cuba and England, all of which have since been discontinued.†

*See Rideal's "Disinfection" (third edition, London, 1903) for a review of the Hermite, Woolf and other attempts to produce sewage and water disinfectants by electrolysis, as well as a discussion of the theory of disinfection by hypochlorite and related substances. From this book it appears that Hermite was granted a British patent in 1893 (No. 22,279); that besides the Ipswich installation the process was tried at l'Orient, Havre and Nice, France; that it was reported on if not tried at Brest, France, and that it was tested with unfavorable results at Worthing, England, early in 1904. The Lancet commission report mentioned in the text (published in the Lancet for May 26, 1894), according to Rideal's "Disinfection," found "no advantage in the Hermite solution over the product obtained by treating chloride of lime in solution with carbonic acid." Roscoe and Lunt concluded from the Worthing tests (again quoting Rideal's "Disinfection") that the Hermite solution "is an excellent deodorizer, but is not by itself applicable as a process of sewage purification."

†The Woolf process for the production of electrozone as installed over 18 years ago at Brewster's, N. Y., to treat the sewage of a few houses before its discharge into a small brook in the Croton drainage area of the New York water supply, was described in a two-column article in our issue of July 13, 1893. In our issues of July 26 (p. 65), Aug. 3 (p. 85) and Aug. 10 (p. 105) notes appeared relating to an extension of the Brewster installation for the purpose of preparing an additional quantity of the so called electrozone for dosing a portion of the Croton water supply during the summer months "to remedy the bad taste, odor and appearance common to stored water at that time."

A Woolf plant was installed at Danbury, Conn., in 1894, to treat the sewage of that city, but was subsequently abandoned, after a hard-fought lawsuit, in which various experts testified. The court held that the plant did not give the remedy against nuisance which had been demanded by riparian owners below the sewer outlet. Intermittent filters were ordered by the court and built

It is not hard to understand why neither Hermite nor Woolf made headway (see also editorial discussion in this issue). Each tried to treat crude sewage. In so far as they aimed to reduce organic matters, other methods then available were more efficient for the purpose, while if disinfection or bacterial reduction were their aim the time had not yet come, if indeed it ever will, when it was other than a waste of good hypochlorite to apply it to an unclarified sewage. Further than this, of course, was the economic question of whether hypochlorites could not be bought more cheaply in the open market than they could be made by local electrolytic methods.

To add to the completeness of our review, mention will be made of a still later attempt to use electrolysis to produce a solution for use in sewage treatment. About 1905, Samuel Rideal tested the effect of "electrolytic chlorine" produced from "brine in a special form of electrolyser owned by the Oxychloride Co." The tests were made at the sewage works of Guildford, England, on effluents from septic tanks and from single, double and triple contact beds. Tests on infected drinking water were also made. Favorable bacterial results were obtained, but the rate of application was generally high and, it appears to us, there is nothing to show either sanitary or economic advantages for this process as compared with one where chemically prepared disinfectants are used.*

Let us now turn to the earlier and somewhat different attempts of Webster and the later efforts of Harris to impress electricity into the purification of sewage or water, by the electrolytic production of reagents within the liquid under treatment.

Twenty-three years ago (see our issues of Apr. 13, and Oct. 26, 1889) we described the Webster process for the electrolytical treatment of sewage by passing it through flumes in which were submerged a series of iron electrodes between which passed an electric current under a potential of about two volts. A plant of this sort on a small working scale, installed at the Crossness outfall of the London main drainage system, was the subject of the second article just named. From that article it appears that Webster claimed for his process both an oxidizing and a precipitating effect. In fact, he provided settling tanks for the reception of the sewage after it had passed the electrodes. From the earlier of the two articles mentioned it also appears that Webster had in mind the formation of hypochlorites or other purifying agents from sea water, thus anticipating Hermite and Woolf, whether or not they utilized his ideas. Webster also proposed a carbon "electric filter" through which, he claimed, liquid already partly clarified by the products of electrolytic action could be brought to a considerable degree of bacterial purity by the action of reagents formed in the filter. Various forms of electrodes were discussed, including those from which aluminum and iron salts might be produced for use as coagulants, somewhat as was done during the Louisville water experiments, mentioned below.

In our issue of May 17, 1890, we described a scheme of treatment which was then being promoted by the Electrical Water Purification Co., of Philadelphia. Except for some American trimmings, this scheme may very readily have been identical with the Webster process, but so far as we know it never got beyond paper.

The Philadelphia company was soon followed (at least in point of time) by a promoter named Harris. He established a small experimental plant in Newark or elsewhere on the Passaic River (in the early nineties, if we remember rightly) for the purpose of proving that he could purify the water of that sewage-polluted stream. This effort came to nothing practical and has probably been forgotten by most of the relatively few who ever heard of it.

So far as a perpetuation of his name was concerned, Mr. Harris succeeded better at Louisville, Ky., in 1896, but according to the classic report on "The Purification of the Ohio River Water at Louisville, Kentucky," by Geo. W. Fuller (New York; 1908) the "Harris Magnetoelectric System was a complete failure."

The same may be said, only in less degree, of the Mark and Brownell electrolytic system, which was tested at Louisville, in 1897, under Mr. Fuller's direction.*

Although the Harris and the Mark and Brownell tests were concerned with water rather than sewage, they deserve mention here: first because of the light they throw upon the Harris devices and promoting methods, particularly his magnetic attachments, used at Santa Monica at first, but later abandoned there and also omitted at Oklahoma City; and second because eighty large pages of Mr. Fuller's Louisville report are devoted to a description of the application of electrolysis to water treatment in the Louisville tests and to a carefully prepared detailed exposition of the theory and practice of the subject. It should be explained, however, that Mr. Fuller treats the whole subject merely as a method of preparing aluminum hydrate and iron hydrate from aluminum and iron plates (electrodes), instead of obtaining the two hydrates from ordinary commercial sulphate of alumina and persulphate of iron, respectively; and these hydrates were to be used as coagulants, prior to sedimentation and filtration. The report shows conclusively that while these hydrates, when produced by electrolysis, had decided advantages over the ordinary forms, their cost was prohibitive. The aluminum hydrate produced by electrolysis cost more than three times as much as that obtained from sulphate of alumina, with no allowance for the installation of electrolytic plant nor for power. The electrolytically produced iron hydrate cost less than the aluminum hydrate, but its cost was still prohibitive.

Particular attention should be called to Mr. Fuller's conclusions as to the absolute uselessness of the Harris magnets, and also of the Harris "sparking drum" for passing high-tension electrical discharges through the water under treatment. Magnets were again used at Santa Monica but the "sparking drum" appears to have been abandoned after its first and brief test at Louisville.

The Harris electric system having gained no foothold in the East in the early nineties, and the Harris magneto-electric system having been subjected to scientific tests and keen scientific analysis at Louisville, in 1896-7, only to be pronounced a marked failure, the promoter seems to have disappeared from water- and sewage-purification circles for many years, only to seek a more virgin field in southern California. In that section, sewage treatment is, relatively speaking, still

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by the city. Editorial reference to the Danbury plant, when it was in the project stage, may be found in our issue of Mar. 22, 1894 (p. 240). The same issue contains an abstract of a valuable paper by the late Thomas M. Drown, on "The Electrical Purification of Water," subsequently published in full in The Journal of the New England Water Works Association.

Electrozone was used temporarily at New York City in 1893 or 1894 to disinfect mixed garbage and refuse as dumped for the enlargement of Riker's Island, in the East River, and for deodorizing the sewage-polluted water in one of the Hudson River boat slips, at or near Canal St.

Electrozone was also used at Havana, Cuba, during the early American occupancy of that city in 1898 or 1899, both for the treatment of sewage discharged through a small pipe into the harbor and for general disinfection in the city.

Rideal, in his book on "Sewage" (third edition, London and New York, 1906, p. 185) mentions the temporary use of Woolf's electrozone to disinfect a sewage effluent from works employing ferozone as a preciptant and polarite for filtration. The "amount of organic matter was hardly reduced," but the "germicidal action was very marked."

*See Rideal's "Sewage" (London and New York, 1906) for further details. For cost figures the author refers to the (London) Electrical Review for Apr. 29, 1898. He also mentions a "Digby process," in which the electrodes are inclosed in asbestos diaphragms "to prevent the salt solution from passing with the liberated irons from the cell," thus reducing the cost of the reagent.

*For the sake of greater completeness of our review, mention may here be made of an installation for treating engine boiler water by electrolysis for the removal of incrusting solids. This plant was tested on the El Paso & Southwestern R.R., at Alamogordo, N. M., in 1907. A paper describing the plant, prepared by J. L. Campbell, El Paso, Tex., engineer maintenance of way of the road named, was published in Am. Ry. Eng. & Maintenance-of-Way Assoc., for May, 1908, and reprinted, with illustrations, in Eng. News, Aug. 13, 1908. The cost of 29 days' operation in January, 1908, when 1,562,400 gal. were treated, was 48c. per 1000 gal., with no allowance for capital charges. The loss of iron (or steel) from the electrodes was at the rate of 6.63 lb. per 1000 gal. The water was settled before and filtered after electrolysis. The hydrate of iron produced from the electrodes could not compete in price with lime and soda ash for throwing down the incrusting solids.

in its infancy, and engineers well experienced in other subjects seem to be little better informed in this one than are laymen city officials and citizens generally.

On the strength of results obtained or claimed by an experimental plant at Ocean Park, near Los Angeles, the city council of Santa Monica contracted for the installation of a "Harris Magneto-Electrolytic plant" to treat the sewage of that city. The contract was made with C. P. Chandler and L. G. Lautzenheiser in behalf of the California Water Purification & Sanitation Co., of Los Angeles (which appears to have been succeeded by the Electro-Sanitation Co., of Los Angeles). According to a paper presented to the Los Angeles Engineers and Architects Association (*Los Angeles Builder and Contractor*, Feb. 18, 1909) by Henry Hawgood, a well known railway and consulting engineer of Los Angeles, the installation was recommended by a board of consulting engineers, including Mr. Hawgood, C. H. Ellison and T. H. James, the latter being city engineer of Santa Monica. Mr. Hawgood served the contractors as engineer. The plant was accepted on Sept. 1, 1908, after a "sixty days' probationary test." Neither the contract guarantees nor the character of the test are stated in Mr. Hawgood's paper. Some inferences as to both may be drawn from a report dated Oct. 22, 1908, recommending the acceptance of the plant. This report was addressed to the city council and was signed by three members of a "sewer committee" and by City Engineer James (see *Daily Outlook*, Santa Monica, Calif., Aug. 26, 1908).

The report opens with the näive statement that *after* the council contracted for the plant the sewer committee "immediately set about to get all the data possible, which would enable them to study the principles involved and enable them to form some idea as to the merits of the system of treating sewage by electrolysis in the plant, while in actual operation." This was certainly laudable, only it would naturally be expected that a "study of the merits of the system" would have been made before rather than after entering into a $10,000 contract.

Nearly half of the report (about two of four newspaper columns) is composed of an extract from Crimp's "Sewage Disposal Works," describing the Webster electrolytic process. A few mis-statements are then made regarding the experience of Boston with sewage disposal. Then comes a curious paragraph on the methylene-blue test for putrescibility, described as coming from Berlin. This is followed by a general summary of the results of 23 methylene-blue tests made at the Santa Monica plant between June 25 and Aug. 21, 1908, which were interpreted as favorable to the process, particularly after some changes had been made in the electrodes.

The average cost of current to treat an assumed daily sewage flow of 500,000 gal. was given in the report as $1.66.

The committee states that it employed Walter B. Gump, of Los Angeles, to report on the electrical equipment, and Dr. Stanley Black, of Pasadena, "to make a bacteriological test." The reports of these men were submitted to the council, but were not printed in the newspaper before us. "These reports," the committee states, "may not be very elaborate as your committee did not feel justified in going to very great expense to obtain them." The context indicates that no "daily working tests" were made by either of the men employed. The report states:

> We are satisfied that an effluent with a maximum amount of purification necessary for deodorization can be maintained indefinitely with a minimum amount of disintegration with iron electrodes using 1.8 volts and 500 amperes representing 4½ hp. at a cost of $1.50 per day of 24 hours.

Belief is expressed that the iron electrodes will last eight to twelve months and that the cost of renewals should not exceed $300.

Finally, the acceptance of the plant was recommended, provided a slight constructional change were made and $1000 withheld from the contract for 60 days "as a further guarantee that the plant will continue to do the work satisfactorily without undue disintegration of the electrodes."

The paper by Mr. Hawgood already mentioned states that the plant was accepted on Sept. 1, 1908, and that up to February, 1909, it had been working satisfactorily. The original electrodes were composed of alternate aluminum and iron plates ⅝ in. c. to c., but these had a useful life of only three weeks. All-iron electrodes were substituted. These lasted better, but were too short-lived until their upper edges were bound with copper. Besides extending the life of the iron "the copper strips, in their decomposition," incidentally "yield copper sulphate and aid in the treatment."

Mr. Hawgood evidently regarded the electrolytic process at Santa Monica as one which, by means of the agents produced, gave rise to an inodorous precipitate, the chief agent being "ferric hydrate formed at the electrodes." But he quoted, with evident approval, a report made to the promoters by Frederick Salathie, setting forth "the chemical and aseptic actions of the process." Mr. Salathie attributed the work effected by the plant to the action of various nascent gases set free by electrolysis, which reduce the organic matter; also to the subsequent formation of various coagulants which clarify the sewage; and finally to oxychloride of lime and magnesia which, with chlorine, nascent oxygen or ozone destroy bacteria. He presented the following analyses, made in July, 1908, to show the effect of the treatment upon certain chemical contents of the sewage:

	Raw sewage	Treated sewage
Organic matter	2.09	1.26
Nitrates	7.4	4.4
Nitrites		3.00
Phosphates	17.4	16.00
Lime	7.35	4.78
Magnesia	9.00	0.98
Oxide of iron	2.72	1.1
Sulphuric acid	14.3	16.2
Chlorine	27.7	11.3

Mr. Salathie appears to have made a little excursion into the bacterial field, which will be of particular interest to bacteriologists. He says:

> The midroscopical examination of a diluted sample for bacteria under 800 magnifying power showed a decrease from 700 live bacteria to 6, and those remaining showed no signs of multiplying, therefore were completely destroyed by the nascent oxygen or ozone and free chlorine gas generated by the electro-chemical process.

This goes well with a statement in one of the bacteriological reports on the Oklahoma City plant, where bacteria not killed are spoken of as "disabled."

Curiously enough, in the paper from which we have been drawing, Mr. Hawgood had nothing to say about the magnets on which Mr. Harris and, at the outset, Mr. Lautzenheiser set so much store.*

It required no large knowledge of either sewage treatment or of the elements of physics to see that the "magneto" element of the Harris system was pure humbug, whatever there might or might not be in the application of electrolysis to sewage. If one had any doubt as to this he need only read the pseudo-scientific jargon of the promoting circulars in which was set forth the valuable part played by the magnets. (See also the Louisville report for a description of the contraptions used there and their uselessness.)

The impression appears to have soon got abroad that the Santa Monica plant worked just as well with as without the magnets. It also appears that the Electro-Sanitation Co., of Los Angeles, which controlled whatever patents were utilized in the Santa Monica plant, passed sooner or later out of the control of Mr. Harris, and that other patents were secured by the company. However this may be, when a licensee under these patents secured a contract for the installation of the Oklahoma City plant (described in the preceding columns), plans were prepared and a plant installed which seems to have omitted all the pure humbuggery of the Harris plants at Louisville and at Santa Monica.

As we have already stated, editorial comments on the Oklahoma City plant appear elsewhere in this issue.

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*Elsewhere Mr. Hawgood barely mentioned the electro-magnets (in a brief note appended to an article by Mr. Lautzenheiser, in the Southwest Contractor and Manufacturer, dated Los Angenel, July 25, 1908); in this article Mr. Lautzenheiser, evidently voicing the claims of Mr. Harris, laid great stress on the value of the magnets, as increasing the "density, intensity and strength" of the electric current used for electrolysis. The magnets were set just above the electrodes.

Code of Principles of Professional Conduct; American Institute of Electrical Engineers

The "Code of Ethics" which was proposed in 1907 for the American Institute of Electrical Engineers by Schuyler S. Wheeler, then President of that Society, and which apparently has been dormant in committee ever since, has again been brought forward under the revised title "Code of Principles of Professional Conduct." It was adopted by the Board of Directors, Mar. 8, 1912, in the form shown below. Comparison with the original "Code of Ethics" (see ENGINEERING NEWS, July 11, 1907) shows that the length has been about halved and that the greatest revision is in regard to ownership of the results of an engineer's work.

While the following principles express, generally, the engineer's relations to client, employer, the public, and the engineering fraternity, it is not presumed that they define all of the engineer's duties and obligations.

(A) GENERAL PRINCIPLES

(1) In all of his relations the engineer should be guided by the highest principles of honor.

(2) It is the duty of the engineer to satisfy himself to the best of his ability that the enterprises with which he becomes identified are of legitimate character. If after becoming associated with an enterprise he finds it to be of questionable character, he should sever his connection with it as soon as practicable.

(B) THE ENGINEER'S RELATIONS TO CLIENT OR EMPLOYER

(3) The engineer should consider the protection of a client's or employer's interests his first professional obligation, and, therefore, should avoid every act contrary to this duty. If any other considerations, such as professional obligations or restrictions, interfere with his meeting the legitimate expectation of a client or employer, the engineer should inform him of the situation.

(4) An engineer cannot honorably accept compensation, financial or otherwise, from more than one interested party, without the consent of all parties. The engineer, whether consulting, designing, installing or operating, must not accept commissions, directly or indirectly, from parties dealing with his client or employer.

(5) An engineer called upon to decide the use of inventions, apparatus, or anything in which he has a financial interest, should make his status in the matter clearly understood before engagement.

(6) An engineer in independent practice may be employed by more than one party, when the interests of the several parties do not conflict; and it should be understood that he is not expected to devote his entire time to the work of one, but is free to carry out other engagements. A consulting engineer permanently retained by a party, should notify others of this affiliation before entering into relations with them, if, in his opinion, the interests might conflict.

(7) An engineer should consider it his duty to make every effort to remedy dangerous defects in apparatus or structures or dangerous conditions of operation, and should bring these to the attention of his client or employer.

(C) OWNERSHIP OF ENGINEERING RECORDS AND DATA

(8) It is desirable that an engineer undertaking for others work in connection with which he may make improvements, inventions, plans, designs, or other records, should enter into an agreement regarding their ownership.

(9) If an engineer uses information which is not common knowledge or public property, but which he obtains from a client or employer, the results in the form of plans, designs, or other records, should not be regarded as his property, but the property of his client or employer.

(10) If an engineer uses only his own knowledge, or information which by prior publication, or otherwise, is public property and obtains no engineering data from a client or employer, except performance specifications or routine information, then in the absence of an agreement to the contrary the results in the form of inventions, plans, designs, or other records, should be regarded as the property of the engineer, and the client or employer should be entitled to their use only in the case for which the engineer was retained.

(11) All work and results accomplished by the engineer in the form of inventions, plans, designs, or other records, that are outside of the field of engineering for which a client or employer has retained him, should be regarded as the engineer's property unless there is an agreement to the contrary.

(12) When an engineer or manufacturer builds apparatus from designs supplied to him by a customer, the designs remain the property of the customer and should not be duplicated by the engineer or manufacturer for others without express permission. When the engineer or manufacturer and a customer jointly work out designs and plans or develop inventions a clear understanding should be reached before the beginning of the work regarding the respective rights of ownership in any inventions, designs, or matters of similar character, that may result.

(13) Any engineering data or information which an engineer obtains from his client or employer, or which he creates as a result of such information, must be considered confidential by the engineer; and while he is justified in using such data or information in his own practice as forming part of his professional experience, its publication without express permission is improper.

(14) Designs, data, records and notes made by an employee and referring exclusively to his employer's work, should be regarded as his employer's property.

(15) A customer, in buying apparatus, does not acquire any right in its design but only the use of the apparatus purchased. A client does not acquire any right to the plans made by a consulting engineer except for the specific case for which they were made.

(D) THE ENGINEER'S RELATIONS TO THE PUBLIC

(16) The engineer should endeavor to assist the public to a fair and correct general understanding of engineering matters, to extend the general knowledge of engineering, and to discourage the appearance of untrue, unfair or exaggerated statements on engineering subjects in the press or elsewhere, especially if these statements may lead to, or are made for the purpose of, inducing the public to participate in unworthy enterprises.

(17) Technical discussions and criticisms of engineering subjects should not be conducted in the public press, but before engineering societies, or in the technical press.

(18) It is desirable that first publication concerning inventions or other engineering advances should not be made through the public press, but before engineering societies or through technical publications.

(19) It is unprofessional to give an opinion on a subject without being fully informed as to all the facts relating thereto and as to the purposes for which the information is asked. The opinion should contain a full statement of the conditions under which it applies.

(E) THE ENGINEER'S RELATIONS TO THE ENGINEERING FRATERNITY

(20) The engineer should take an interest in and assist his fellow engineers by exchange of general information and experience, by instruction and similar aid, through the engineering societies or by other means. He should endeavor to protect all reputable engineers from misrepresentation.

(21) The engineer should take care that credit for engineering work is attributed to those who, so far as his knowledge of the matter goes, are the real authors of such work.

(22) An engineer in responsible charge of work should not permit nontechnical persons to overrule his engineering judgments on purely engineering grounds.

(F) AMENDMENTS

Additions to, or modifications in, this Code may be made by the Board of Directors under the procedure applying to a by-law.

The Adherence of Flat Surfaces, as observed in the case of the modern steel end-gages used in precise instrument and tool making, has been commonly ascribed to molecular adhesion. This theory was advanced because the force required to separate two of the steel blocks or gages that had been "wrung" together was found to be greater than that due to atmospheric pressure. A new theory is advanced by H. M. Budgett, in a paper read before the British Royal Society, as the result of extensive tests on cylindrical blocks with an area of 0.7 sq.in. on the contacting surfaces.

In these tests the surfaces were covered with extremely thin films of various liquids including condensed water vapor, turpentine and various oils and viscous liquids. The greatest adherence was observed with the condensed water-vapor film, for which the maximum pull required to separate the surfaces was over 90 lb. per sq.in. and the average was 50 lb. No adhesion could be obtained with volatile liquids, such as alcohol, benzine and gasoline. The author's chief conclusions are as follows:

(1) That at least 75% of the adhesion is caused by the presence of a liquid film between the faces in contact.
(2) That not more than 25% is due to atmospheric pressure.
(3) That the adhesion practically vanishes when no film is present.
(4) That the attraction of the molecules of steel in one face by those in the opposite face is negligible.

FIELD AND OFFICE

Erecting 110-ft. Plate-Girders with a Long-Reach Derrick Car

By E. A. Gibbs*

The new extension of the Western Maryland Ry. from Cumberland, Md., to Connellsville, Penn.—known in Pennsylvania as the Connellsville & State Line Ry.—crosses the Youghiogheny River over steel bridges at three points. Two of these bridges are in Ohio Pyle, Penn., a small village in the Alleghany Mountains a few miles east of Connellsville. The map of the line at Ohio Pyle, in Fig. 1, indicates their location. Both bridges are made up of plate-girders. The north crossing consists of 110-ft. square deck spans, the south crossing of seven 80-ft. skew deck spans and one 60-ft. square through span.

The girders of the south crossing were set with a 50-ton steel derrick car using a 50-ft. boom, and the handling of the work involved no special equipment or methods. The erection of the girders in the north crossing, however, presented rather unusual features, and this work is described in the following.

The piers at the center of the river are nearly 100 ft. high. The bridge is approached from the south by a 5° curve on a fill about 500 ft. long, beginning at grade and reaching a depth of 40 ft. at the east abutment. The fill, having been completed but a short time before the arrival of the steel, was very soft and yielding, and required frequent ballasting to sustain the heavy loads brought upon it during the erection of this work.

The usual method of setting heavy girders, by carrying them with a high boom on a self-propelling car to the end of the last span set and then lowering them to the river bed and working the girder out to the center of the span by alternately hoisting the load and lowering the boom, would have been slow, and the same operation carried on with the girder at the grade level would have been dangerous by reason of the difficulty of controlling the boom.

It was therefore decided to reinforce and counterweight the car so that these 110-ft. girders, weighing about 45 tons each, could be carried by the load falls 60 ft. ahead of the car, and to propel the car under its own steam with the boom in this position until the front trucks reached the end of the last span set, when the car could be blocked, the rail clamps fastened, the side guys tightened and the girder lowered and swung into position.

The derrick car, a 50-ton steel car as manufactured by the American Equipment Co., required reinforcement in the following points:

1. A new 70-ft. boom capable of supporting 45 tons at a radius of 60 ft.
2. New boom-hoisting falls with a heavier attachment at the head of the A-frame.
3. A new footblock for the boom.
4. New and heavier front truck capable of traveling with a load of 160 tons.
5. Additional counterweight, about 30 tons, placed as described later.

The new boom is composed of four angles 5x3½x½ in. and 2⅞-in. web plates, and is 2 ft. 6 in. deep and 2 ft. 3 in. wide at the center.

The boom falls consist of 19 parts of ¾-in. extra strong crucible cast-steel hoisting cable, rove over 3-sheave and 6-sheave blocks. The 3-sheave blocks have 16-in. sheaves and the 6-sheave blocks 20-in. sheaves, the 3-sheave blocks being pin-connected to the 6-sheave blocks which are in turn connected to the end of the boom and the top of the A-frame. The cable was rove first over two 20-in. sheaves and then over one 16-in. sheave, thus keeping the various parts nearly parallel and decreasing the friction. All sheaves are bushed with metalline.

The 19 parts of cable were required to resist the stress in the boom falls when carrying the maximum load at the extreme radius. The boom being neither elevated nor lowered, the total strength of the 19 parts was available. Raising or lowering the boom while supporting the maximum load would, undoubtedly, have caused a reduction of 50% in the strength of the cable, due to friction. As a matter of fact, however, while the boom was not raised when supporting this load it was lowered several times during the setting of the first two spans and no difficulty experienced, the cables playing freely over the sheaves. The car was fitted throughout with new cables for this work, the cables being in excellent condition upon its completion.

All boom and headblock pins and forgings are of forged nickel-steel.

The front truck is a four-wheel truck of the Bettendorf type with cast-steel side frames and bolster, forged steel wheels and 6x11-in. journals. It was subjected to a minimum load of 160 tons, this load existing during the travel of the car a distance of about 75 ft., carrying a girder at the extreme radius. The load of 40 tons per wheel developed no excessive stress in the supporting girders.

The counterweight was provided by inserting a 30-ft. steel box-girder in the space provided for shipping the ordinary 50-ft. boom. This girder rested directly on the center box body girder of the car, was clamped to it with steel yokes, and extended beyond the car about 15 ft. over the top of a flat car coupled to the derrick car. A platform was built of heavy timbers on top of the projecting end of the counterweight girder, and upon this platform were placed several tiers of steel stringers, belonging to a near-by truss span, held in position by rods. The counterweight girder was rigidly clamped to the derrick-car body, but cleared the flat car by 1 in. and was perfectly free to swing laterally over it as the derrick car

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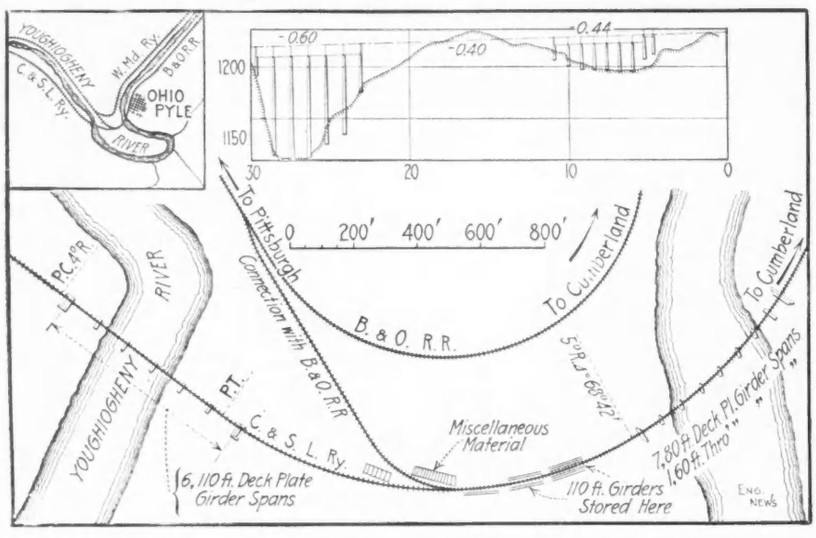


FIG. 1. MAP OF WESTERN MARYLAND RY. AT OHIO PYLE, PENN., AND LOCATION PLAN OF YOUGHIOGENY RIVER BRIDGES

passed around the curve. Longitudinal bearing timbers were placed along the sides of the flat car underneath the platform so that the platform and its load could not overturn. There were also provided two 1⅛-in. hoisting cables, one on each side of the car, running from the top of the A-frame to the rear end-sill of the flat car and thence to the forward end-sill where they were securely fastened. A heavy steamboat ratchet was connected into each cable under the car in order that the cables might be slacked off in running around the curves and then tightened up when out on the bridge where the counterweight was required.

A heavy truck capable of carrying 75 tons was improvised from the old front truck of the derrick car.

The girders were delivered by the B. & O. R.R. over a track connection, and unloaded where shown in Fig. 1.

When it was desired to load a girder on the truck, the falls attached to the side of the head of the A-frame to prevent the car from overturning, usually called "quarter-falls," were attached to pennant lines running to anchorages and the rail clamps were fastened. The girder was then lifted by the load falls, set on the truck, and braced. As the grade is descending toward the bridge little effort was required for the derrick car to push the loaded truck to the bridge.

The first two spans were set in the usual manner because the track on the fill and on the first span is on a curve and it is not safe to propel the car carrying a heavy load on a curve. Moreover, the fill at this abutment was too soft, even after a solid bed of 12x12's had been laid.

The remainder of the spans were set as follows: Each girder was loaded on the truck as above described, and pushed ahead of the derrick car out on the bridge until the truck was at the extreme outer end of the last span set, where it was blocked. The girder hooks fastened to the lower block of the load falls were attached to the girder, which was then hoisted clear the truck. The truck was then run out on the projecting ends of the 90-lb. track rails, which supported it and allowed the derrick car to proceed until the end of the car was flush with the end of the last span set. At this point the derrick car was blocked, clamped to the rails, and the quarter falls tightened; then the girder was lowered to the pier and swung laterally into position, with the near end on the permanent shoe and the forward end set on blocking which was carried out by men walking along the suspended girder.

It had been intended to fasten this forward shoe, which was the fixed one, to the end of the girder and set the girder in its permanent position at once. But as the grillage for the expansion end of the adjacent girder was attached to the same masonry plate, the shoe would have made the girder unwieldy to handle and increased the load appreciably.

While traveling the distance of about 75 ft. with the girder suspended from the boom, the quarter falls attached to the sides of the A-frame were allowed to hang slack, but side guy falls or "tag" lines were used on the extreme outer end of the boom and were kept taut by running the leads over winch heads on the engine.

Eight girders or four spans were set in the manner above described. No difficulty was experienced in any of the operations.

The weight of the individual girders varies from 43 to slightly over 44 tons, and the total weight of steel in the structure is 588 tons.

The timber deck of this bridge is composed of 8 by 14-in. by 12-ft. yellow-pine ties spaced 4 in., every fourth tie projecting to carry a footwalk and hand railing. There is a total of 120 M ft. b.m. in the deck of this structure.

The work was designed under the direction of Mr. H. R. Pratt, Chief Engineer of the Western Maryland Ry., by Mr. A. W. Buel, Consulting Bridge Engineer. The steel-work was furnished and erected by the McClintic-Marshall Construction Co., of Pittsburg, Penn.

FIG. 2. 110-FT. GIRDER ON TRUCK

FIG. 3. GIRDER CARRIED FORWARD BY DERRICK; TRUCK PUSHED OUT ON OVERHANGING RAILS

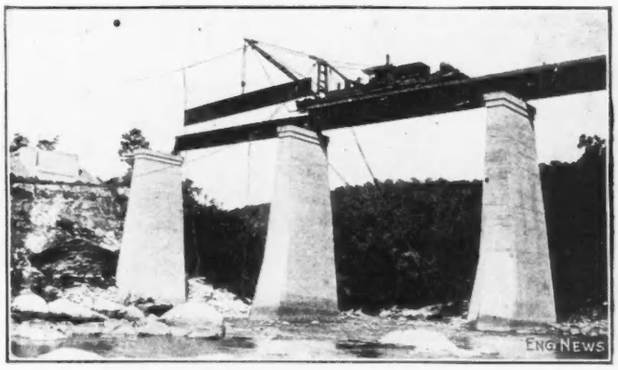


FIG. 4. DERRICK CAR CARRYING THE GIRDER FORWARD, WITH SLACK QUARTER FALLS AND TAUT TAG LINES

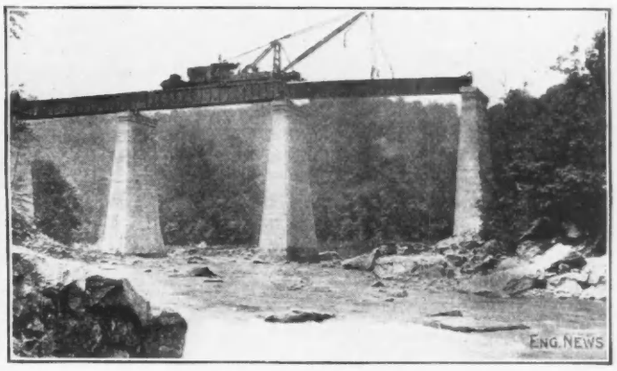


FIG. 5. SWINGING GIRDER INTO FINAL POSITION; DERRICK CAR BLOCKED, AND ALL SIDE FALLS TAUT

Approximate Design in Structural Steelwork

By George A. Merrill*

The structural engineer employed by a bridge company or structural steel shop is often called upon to work out a design and prepare an estimate at short notice. A bid must be put in, based on fairly accurate data, or a possible contract lost.

During a period of estimating covering some years the writer has derived certain rules and formulas to lighten his labors and to abbreviate his work as much as possible. As his experience has been mainly with building work, this paper will deal more particularly with the steelwork of office buildings and warehouses.

Estimating by Cubic-foot Weights—If time is very limited, or only a very approximate estimate of the weight and cost of the steel frame is desired, the weight per cubic foot of a similar building with about the same floor loads and floor construction can be used. In order to have such information at hand when wanted, the engineer should keep a record of every building he designs, noting therein its height, width and breadth; the style of floor construction; the material and thickness of the walls and whether they are self-supporting or not; the live loads used upon the floors; and finally the weight of steel per cubic foot.

If more detailed and accurate results are desired, some designing must be done.

Estimating from Approximate Design

On the architect's blueprint showing a typical floor, or upon a separate sheet traced from the architect's plan, the engineer pencils in that framing of girders and beams which appears from inspection to give the most economical layout. The location of the columns has generally been determined by the architect and cannot be changed. It remains to figure the sizes of the beams.

Beam Sizes—In general, in an office building or warehouse, similar beams occur in succeeding tiers, having the same span and spacing, but with a different loading per square foot. On this account it is best to write down under the line on the plan representing the beam in question, its size in every tier from basement to roof, making one plan as far as possible serve for all floors and roof. The live-loads upon each floor are known, being determined by regulation or by the architect. The dead-load per square foot must be approximated, which approximation is easily made. Given the span, spacing of beam, and total load per square foot, the size of the beam is readily determined. The figures for beam spacings under various loads given in "Carnegie" may be used, or one of the sliding beam scales.

*Structural Engineer, H. P. Converse & Co., Boston, Mass.

Another method of getting beam sizes is available, which does not require reference to steel handbook or beam scale, but calls for a simple multiplication, made with the slide-rule or otherwise. Before giving this rule, a hint regarding the spacing of beams may be of use. In scaling from the plan the spacing of the beam in question, the two spaces on either side of the beam should not be scaled, then added together and their average taken; instead, both spaces should be measured as one space, but with a scale twice that on which the plan is drawn, thus obtaining the spacing at once.

The following beam formula is known by many structural engineers, and should be known by all; it gives surprisingly accurate results with a minimum of labor:

Safe load in thousands of pounds = *Weight of beam* per linear foot *multiplied by Depth* in inches and *divided by Span* in feet.

Example: 1. According to this rule, at 16,000 lb. fiber stress, a 12-in. x 31½-lb. I-beam 18 ft. long will carry

$$\frac{31.5 \times 12}{18} = 21(000)\ lb.$$

The Carnegie handbook gives 21,320 lb.

2. A 10-in. x 15-lb. channel 15 ft. long will carry

$$\frac{15 \times 10}{15} = 10(000)\ lb.$$

Carnegie gives 9500 lb. It will be found upon referring to a steel handbook that 1000 × weight of beam × depth in inches corresponds closely to the figures for safe load for a beam 1 ft. long.

The formula or rule above given can be transformed thus:

$$0.001\ W \times s\ S^2 = d\ w'$$

in which

W = Total load per square foot,
s = Spacing of beam in feet,
S = Span of beam in feet,
d = Depth of beam in inches,
w = Weight of beam per foot.

It helps the designer to have before him a table of the values $d\ w'$, or better still to commit these products to memory; thus $4 \times 7\frac{1}{2} = 30$, $6 \times 12\frac{1}{4} = 73\frac{1}{2}$, $7 \times 15 = 105$, etc.

Wall Beams—If the walls are self-supporting, a wall channel of the same depth as the adjacent beam and of approximately one-half its weight is required. If the wall is carried on steel, a little preliminary work is required before applying the formula. Having the (average) story height, the (average) thickness of wall, and the (average) percentage of window space, the weight of wall per linear foot of beam is obtained and this must then be transformed into an equivalent space of floor load, which is done by dividing by the floor load per square foot.

Thus, suppose the story height is 12 ft., the curtain wall 12 in. thick, of brick, with windows out, amounting to 70% solid brickwork; if the total live and dead-load is 200 lb., then

$$\frac{0.70 \times 120 \times 12}{200} = 5\ ft.$$

the equivalent width of floor load. The engineer would then draw on his plan imaginary beams 10 ft. outside the wall line, and thereafter deal with the wall beams just the same as with the interior beams. Note, however, that the formula gives product of weight by height, and that for a compound wall beam this is the sum of the "products" of two beams or a beam and channel; generally the beam and channel are of the same size, so that the combined weight can be obtained readily for a given depth. The matter of shelf angles for such wall sections is left to the judgment of the designer.

Girder Beams—With girder beams, to use the formula, concentrated loadings must generally be transformed into equivalent uniform loadings. The bending moment for a beam freely supported at the two ends is:

For a uniform load

$$M = \frac{WL}{8}$$

For a concentrated load of ½ W at center of span

$$M = \frac{WL}{8}$$

For two concentrated loads of ⅓ W at the third points

$$M = \frac{WL}{9}$$

For three concentrated loads of ¼ W at the quarter points

$$M = \frac{WL}{8}$$

For four concentrated loads of ⅕ W at the fifth points

$$M = \frac{3\,WL}{25}\left(\text{or practically } \frac{WL}{8}\right)$$

From these formulas we deduce the following rules for girder beams: (a) For one floorbeam coming at center, or for three or more floorbeams spaced at equal and symmetrical intervals along the girder, the spacing is the same as if the girder beam carried a uniform load extending to the next girder beam.

(b) For two floorbeams coming in at the third points, consider the load as uniform, but the adjacent girder eight-ninths of its actual distance away.

If the girder beam has a uniform loading on one side and unsymmetrical concentrated loadings upon the other, the spacing upon both sides must be found and the average taken, to arrive at the spacing to be used in the formula. For girder beams with floorbeams coming in unsymmetrically, the engineer must use

his judgment with regard to the equivalent spacing.

PLATE-GIRDERS—The formula above stated gives a very close approximation for weight only; for example, given $W = 200$, $s = 20$ ft., $S = 40$ ft., then $0.2 \times 20 \times 1600 = 6400 = d\ w'$; if $d = 40$ in., $w' = 160$ lb.; allowing 15% for rivets and fittings, the formula gives a 40-in. plate-girder weighing 184 lb. per ft. If this be checked, it will be found that a plate-girder made up of 1 web 40x⅜ in., 4 angles 6x4x⅞ in., and 2 plates 10x$\frac{7}{16}$ in. is required, weighing with 15% allowance for fittings 176 lb. per ft., or about 5% less than the approximate weight.

TRUSSES—For trusses there are no very close approximate rules. It has been the writer's practice, when pressed for time, to estimate the trusses in a building as plate-girders, using as the depth of girder the average depth of truss, and employing the rule above given.

COLUMNS—For approximate results, summarize the total load coming upon the column considered, at a point in the building one story below mid-height, using the common method of contributing floor area multiplied by total load; and divide the total load by 13,000 and multiply by 4.4. This approximation gives a fairly close average weight per foot of column from basement to roof. The story heights in most office buildings are such that a column section can be readily found where $\frac{l}{r}$ is 70 or less, so that the column can be figured at 13,000 lb. per sq.in. without deduction. The cubic inches of cross-section thus obtained, when multiplied by 3.4, give the theoretical weight per linear foot, and if 25% is added to take care of fittings and 5% for difference between theoretical section and the section as used, we have 4.4 as the factor to be used.

The column should be figured for a total load at a floor a story below mid-height, to take care of the condition that the top lengths of columns often have their cross-sections determined by the value of $\frac{l}{r}$ or from practical considerations and not by their supported loads, and are therefore somewhat heavier than the consideration of load alone would make them.

The writer offers these rules and suggestions not as any substitute for painstaking design and study, but to show how a surprisingly accurate design (considering the method employed) can be made and an estimate prepared in a very short time.

It is possible at times by these methods to prepare both design and estimate without reference to any handbook or tables. The methods will also be found to be of use in checking designs made in the usual way.

Notes

Problem in Street Location—The accompanying problem occurred in laying out a curved roadway for the Department of Public Parks of Indianapolis, Ind. The problem and solution are sent to us by R. R. Cook, of the Office of the Board of Park Commissioners, who states that it is the most simple solution he has been able to determine.

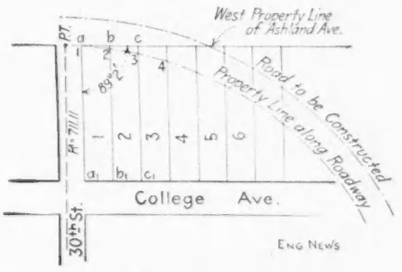


FIG. 1. GIVEN PROBLEM: TO FIND LENGTHS a1, b2, b3, ETC.

Fig. 1 gives the conditions of this particular layout. It is required to find a-1, b-2, c-3, etc., the distances from the west property line of the lots 1, 2, 3, etc., to the new property line on the curved roadway, the radius and center of which are, of course, known. The distances of the lot corners a, b, c, etc., from the P.T. are easily measured and are, therefore, known. The angle a_1ac, which is not a right angle, is known, and the lot lines a_1a, b_1b, c_1c, etc., are parallel.

The equation of a circle tangent to the Y axis at the origin and the center of which is on the X axis is, $y^2 = 2\,R\,x - x^2$. Referring to Fig. 2, we have OA = y, angle A2B = α, and R = radius of property line along proposed roadway.

For point 1 on the arc we have,

$$y^2 = 2\,Rx - x^2 \qquad (1)$$

and for point 2,

$$(y + \Delta y)^2 = 2\,R\,(x + \Delta x) - (x + \Delta x)^2 \qquad (2)$$

and we have,

$$\frac{\Delta y}{z} = \sin \alpha, \text{ or } \Delta y = Z \sin \alpha \qquad (3)$$

$$\frac{x + \Delta x}{z} = \cos \alpha, \text{ or } x + \Delta x = Z \cos \alpha \qquad (4)$$

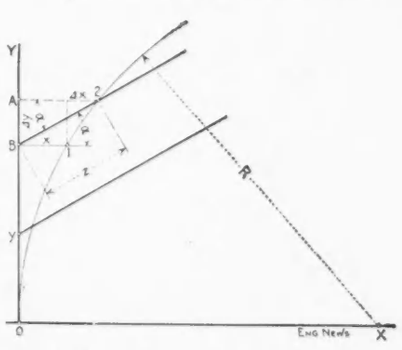


FIG. 2. SOLUTION OF PROBLEM IN STREET LOCATION

Substituting these expressions in equation (2) we have,

$$(y + z \sin \alpha)^2 = 2\,R\,(z \cos \alpha) - (z \cos \alpha)^2$$

which reduces to,

$$z^2 + z\,(2\,y \sin \alpha - 2\,R \cos \alpha) + y^2 = 0$$

which may be solved for z, the required distance.

A Printing-Press Gear Problem is put by Herbert M. Lloyd, Treas., American Paper Goods Co., 92 William St., New York. The problem is to derive the equation for the curve F C G in the accompanying illustration. This curve is the pitch line of that portion of the gear at the right which engages the flat portion D C E of the one at the left.

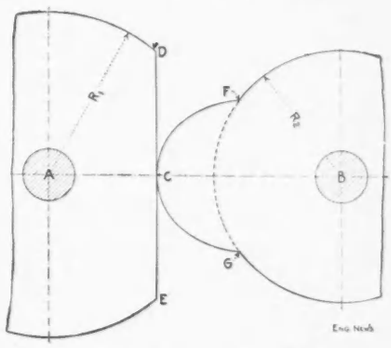


DIAGRAM FOR PRINTING-PRESS GEAR PROBLEM

The radii R_1 and R_2 of the circular portions of the pitch lines of the two gears are given; also the distances A C and C B. The gear at the left turns about the shaft A and the other about the shaft B. The conditions of the problem require that the length C D shall be equal to the length C F, measured along the unknown curve, and that the curve C F shall be always in rolling contact with the line C D as the two gears turn about their respective centers A and B.

Any reader who takes particular pride in mathematical ability will find this to be a puzzler worthy of his best efforts. It should be added that gears of this shape have been made—plotting the curve C F by graphical methods.

The Stadia for Preliminary Railway Surveys—The advantages of the stadia for topographical surveys have been argued time and time again, and the adaptability of the method to preliminary railway surveys is a subject which has been thoroughly discussed, as many of our older readers are well aware. An excellent summary of the advantages of the stadia in railway location work and many useful hints for its use can be found in Engineering News of Feb. 21, 1901, page 133, an article by H. P. Boardman, then Assistant Engineer of the Chicago & Alton R.R. Yet, apparently, in spite of all that has been written and spoken, railway location engineers are reluctant to give the stadia a fair trial. A correspondent, in Denver, Colo., writes as follows:

It is strange that the stadia is not more used for preliminary railway surveys in difficult countries. None of the large roads use it—I speak from experience in every state between Lake Michigan and the Pacific Ocean. Small corporations which have no engineering departments with fixed old ideas have permitted me to use the stadia enough to satisfy me that 15- to 20-men parties in rough preliminary survey work are radically wrong. With one-fourth that force and the stadia I can do more and better work in the same time.

On the Pacific Coast, which is one of the most difficult sections for surveys, railway stockholders have lost much money, and many engineers have lost their reputations, in using old methods. In one headquarters there have been six

different chief engineers in as many years. A dozen parties have been sent into one county in a desperate attempt to get a line. Promoters have bought all the timber land for sale, relying on promises of a railway; yet nothing has been done because a survey that can pass inspection has not been made.

Large parties of cheap men cannot be handled or cared for. There is constant dissatisfaction and change. To keep the cook is by no means the least problem. The cook must have a flunky, a fine cooking range, and what not. I have seen one chief-of-party flunkying to keep the cook and finally doing the cooking himself. Anything for the salary and title he never had before.

Where a party cannot reach the country where they want to survey, I have seen them survey such country as they could reach. Lines have been run along trails over hill and dale when there was a water grade half a mile away in the wet brush. A report of miles run must be sent to headquarters each week. There is no end of difficulties working in the rough country under these conditions.

A small stadia party can move every day and carry all the equipment on the backs of the men. Trails are not necessary and the party can penetrate anywhere. Such a party would consist of a transitman, rodman, two axemen and a cook. The chief-of-party himself would act as rodman, and select the salient points. For the final line where the compass needle could not be used for backsights a back-flagman and a stakeman should be added.

The locating engineer may have several such parties out in the vicinity, keeping a camp of his own on the trail, where profiles and maps may be made and compared, and supplies for the parties kept. Final locating parties need not stake out the line until they can go out over the contractor's roads.

For accuracy the stadia is better than the tape on slopes, with the kind of tapemen usually available. For that reason I have used it on townsite work. For contour work (in which preliminary railway location consists in a large measure) it is ideal.

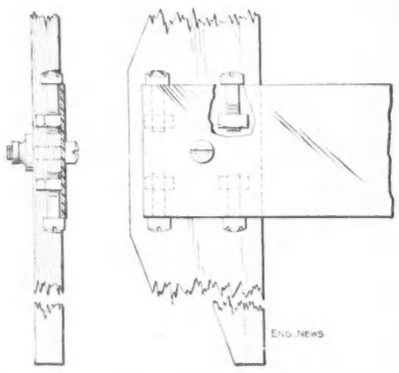
A. M. H.

Denver, Colo.
Dec. 18, 1911.

Steel-Bladed T-Squares — Mr. H. K. Higgins, of 35 State St., Boston, Mass., describes a steel-bladed T-square of simpler and cheaper construction than that described in an article published in our issue of Dec. 21, 1911. Mr. Higgins, like Mr. Colles, the author of the article referred to, uses a Brown & Sharpe steel straight-edge for the blade of his T-square, but the head is a hardwood piece 12 in. long by 2¼ in. wide and ½ in. thick. The head is fastened to the blade with one fillister-head machine bolt (No. 14, 24-pitch), as shown in the accompanying illustration. The machine bolt has a thumb-nut put on upside down to secure greater area on the wood.

e head is adjusted square to the blade by four fillister-head machine bolts of the same size as the first and ¾ in. long. The nuts for these four bolts are filed or cut to clear the blade and are set into the wooden head, as shown in the illustration, so as to allow the edges of the fillister heads to engage the edges of the straight-edge. The heads of these bolts have two screwdriver slots at right angles to each other, so as to allow the use of an adjusting pin to set them up while in place in the wooden head.

Mr. Higgins states that he has used a T-square of this sort with a 42-in. straight-edge for a blade for some 14 years on both structural and machine work, with perfect satisfaction. He states, however, that the wooden head is subject to the objection that the face in contact with the edge of the drawing board wears to a convex surface, but



ATTACHMENT OF STEEL BLADE TO WOODEN T-SQUARE HEAD

this convexity he has easily corrected by the use of a sheet of sand paper at intervals of about once a year.

Mr. Higgins uses as a working edge for his drawing board a 30-in. steel straight-edge attached to the board by means of two angle-shaped brackets of ¾-in. x ⅝-in. hard rolled brass. One arm of the bracket is made long enough to support the straight-edge at a distance from the edge of the board just great enough to avoid contact at any point. The brackets are placed 6 in. from the ends of the straight-edge blade, which is attached to them by means of No. 8 32-pitch machine screws, with nuts and washers. The short legs of the brackets are attached by means of wood-screws to the edge of the drawing board. The hole in the short leg of the bracket is made oval to allow adjustment of the straight-edge to a plane just below that of the drawing.

Tables for the Strength of One-Line Rivet Connections under Eccentric Load

BY E. L. WOOD*

One chief objection to tables for computing the strength of eccentric riveted connections is that a kind of "cut and try" method must be used in their application; an assumption is first made, and then with the aid of tables it is ascertained whether or not the assumption is correct.

The accompanying tables are designed to obviate any preliminary assumptions, and will give results directly, within the limits for which they are computed, with a minimum of computation.

According to the usual theory an eccentrically loaded group of rivets is subjected to two stresses acting at an angle with each other; a direct stress S_d due to the load, and a stress S_m due to the moment caused by the eccentricity of the load. These two stresses combined give the resultant stress S_r (Figs. 1 and 2). The stress S_m for any rivet is proportional to its distance from the center of gravity of the group, while the stress S_d is the same for each rivet, and is equal to the load divided by the number of rivets.

Let

W = Load,
L = Eccentricity,
n = Number of rivets,
p = Pitch of the rivets,
v = Allowable stress on one rivet,
M = Moment value of the rivet group for a stress of unity in the extreme rivet.

The area of one rivet is assumed to be unity. Then, for *a single row of rivets*,

$$\sqrt{S_m^2 + S_d^2} = S_r$$

or in terms of the known quantities

$$\sqrt{\left(\frac{WL}{M}\right)^2 + \left(\frac{W}{n}\right)^2} = v \qquad (1)$$

Let $C = \frac{W}{v}$; then $W = vC$; substituting this value of W in equation (1) we have,

$$\sqrt{\left(\frac{vCL}{M}\right)^2 + \left(\frac{vC}{n}\right)^2} = v$$

Whence we get the value of C,

$$C = \sqrt{\frac{M^2}{L^2 + \frac{M^2}{n^2}}} \qquad (2)$$

For an odd number of rivets we know that:

$$M = \frac{4p}{n-1}\left[1^2 + 2^2 + 3^2 \cdots \left(\frac{n-1}{2}\right)^2\right] \qquad (3)$$

And for an even number of rivets:

$$M = \frac{4p}{n-1}\left[0.5^2 + 1.5^2 + 2.5^2 \cdots \left(\frac{n-1}{2}\right)^2\right] \qquad (4)$$

Equations (3) and (4) express the value of M in terms of p; let b stand for the coefficient of p in (3) and equation (2) becomes,

$$C = \sqrt{\frac{b^2p^2}{L^2 + \frac{b^2p^2}{n^2}}} \qquad (5)$$

This is a convenient form for computation with a slide-rule, and the accompanying tables are so computed. It should be noted that the value of C in this equation depends solely upon the number and spacing of rivets and the eccentricity of the load, and is independent of the size of rivet or unit stress. Therefore the tables are adapted to any size of rivets or any desired specifications.

*Bethlehem, Penn.

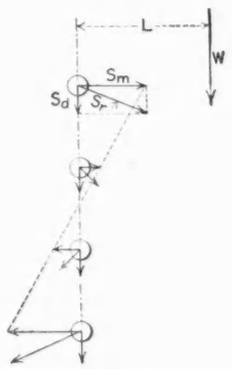


Fig. 1

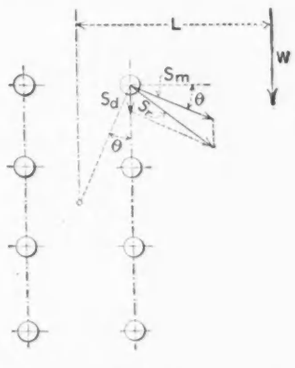


Fig. 2

ENG. NEWS

FORCES ACTING ON RIVETS IN ECCENTRIC CONNECTIONS

TABLE I. ECCENTRICALLY LOADED RIVETED CONNECTIONS. COEFFICIENT C FOR ONE ROW OF RIVETS

Rivets 2½-in. Pitch

No. of Rivets	Eccentricity of Load (L) 2	3	4	5	6	7½	9	10½	12	15	18	21	24
2	1.06	0.77	0.60	0.49	0.41								
3	1.92	1.46	1.15	0.95	0.80	0.65	0.55	0.47	0.41				
4	2.88	2.28	1.85	1.54	1.31	1.07	0.90	0.78	0.68	0.55			
5	3.90	3.20	2.65	2.24	1.92	1.58	1.34	1.16	1.02	0.82	0.69	0.59	0.52
6	4.95	4.19	3.54	3.03	2.62	2.18	1.85	1.61	1.42	1.15	0.96	0.83	0.72
7	6.00	5.20	4.48	3.88	3.40	2.84	2.43	2.12	1.87	1.52	1.27	1.10	0.96
8	7.07	6.25	5.48	4.81	4.25	3.58	3.08	2.69	2.39	1.94	1.63	1.41	1.24
9	8.12	7.30	6.50	5.76	5.13	4.37	3.78	3.32	2.95	2.41	2.03	1.75	1.54
10	9.16	8.36	7.53	6.75	6.06	5.21	4.54	4.00	3.57	2.92	2.47	2.13	1.87
11	10.21	9.43	8.59	7.78	7.05	6.10	5.34	4.74	4.23	3.48	2.94	2.55	2.24
12	11.27	10.50	9.66	8.82	8.05	7.04	6.19	5.51	4.94	4.08	3.46	3.00	2.64
13	12.30	11.57	10.73	9.87	9.06	7.99	7.08	6.32	5.69	4.71	4.01	3.48	3.07
14	13.33	12.62	11.80	10.93	10.10	8.96	8.35	7.16	6.47	5.39	4.60	4.00	3.53
15	14.37	13.68	12.86	12.00	11.15	9.97	8.93	8.04	7.29	6.09	5.21	4.54	4.02
16	15.40	14.72	13.93	13.08	12.20	10.99	9.86	8.94	8.13	6.83	5.86	5.16	4.59

Rivets 3-in. Pitch

2	1.20	0.89	0.70	0.57	0.48	0.39							
3	2.12	1.66	1.34	1.12	0.95	0.77	0.65	0.56	0.49				
4	3.12	2.56	2.12	1.79	1.54	1.27	1.07	0.93	0.82	0.66	0.55	0.47	0.41
5	4.16	3.54	3.00	2.57	2.24	1.86	1.58	1.37	1.21	0.98	0.82	0.71	0.62
6	5.21	4.55	3.95	3.44	3.02	2.54	2.18	1.90	1.68	1.36	1.15	0.99	0.87
7	6.26	5.60	4.95	4.38	3.88	3.29	2.84	2.49	2.21	1.80	1.52	1.31	1.15
8	7.31	6.65	5.98	5.35	4.80	4.12	3.58	3.15	2.81	2.30	1.94	1.68	1.47
9	8.36	7.72	7.03	6.37	5.76	5.00	4.37	3.87	3.46	2.85	2.41	2.08	1.83
10	9.40	8.78	8.09	7.40	6.76	5.91	5.22	4.63	4.17	3.44	2.92	2.54	2.24
11	10.44	9.84	9.15	8.45	7.78	6.87	6.10	5.46	4.92	4.09	3.48	3.02	2.67
12	11.48	10.90	10.22	9.52	8.82	7.86	7.03	6.32	5.72	4.77	4.08	3.55	3.14
13	12.50	11.96	11.30	10.59	9.87	8.87	7.98	7.21	6.55	5.50	4.71	4.11	3.64
14	13.53	13.00	12.36	11.65	10.93	9.90	8.95	8.14	7.43	6.27	5.39	4.71	4.18
15	14.55	14.05	13.42	12.72	12.00	10.94	9.96	9.09	8.32	7.06	6.09	5.34	4.74
16	15.58	15.09	14.48	13.80	13.08	12.00	10.99	10.07	9.25	7.89	6.83	6.00	5.34

Rivets 3½-in. Pitch

2	1.32	1.01	0.80	0.66	0.56	0.45							
3	2.28	1.84	1.51	1.27	1.09	0.89	0.75	0.65	0.57				
4	3.30	2.79	2.36	2.02	1.75	1.45	1.26	1.07	0.95	0.76	0.64	0.55	0.48
5	4.35	3.80	3.30	2.87	2.52	2.12	1.81	1.58	1.40	1.14	0.96	0.82	0.72
6	5.39	4.84	4.29	3.80	3.38	2.83	2.48	2.17	1.93	1.58	1.33	1.15	1.01
7	6.44	5.89	5.32	4.78	4.30	3.70	3.22	2.81	2.54	2.08	1.76	1.52	1.34
8	7.48	6.95	6.36	5.79	5.26	4.59	4.03	3.58	3.21	2.64	2.24	1.94	1.71
9	8.52	8.01	7.43	6.84	6.28	5.53	4.90	4.37	3.94	3.26	2.78	2.41	2.12
10	9.55	9.05	8.46	7.88	7.30	6.50	5.80	5.21	4.71	3.93	3.36	2.92	2.58
11	10.58	10.11	9.55	8.95	8.35	7.51	6.76	6.11	5.55	4.66	3.99	3.48	3.08
12	11.60	11.17	10.62	10.03	9.41	8.53	7.74	7.03	6.42	5.41	4.66	4.08	3.62
13	12.63	12.21	11.68	11.09	10.48	9.57	8.74	7.98	7.33	6.22	5.38	4.72	4.19
14	13.66	13.25	12.73	12.17	11.56	10.63	9.76	8.96	8.25	7.06	6.13	5.39	4.80
15	10.67	14.28	13.79	13.22	12.62	11.69	10.80	9.97	9.21	7.93	6.91	6.09	5.44
16	15.68	15.50	14.83	14.29	13.68	12.76	11.85	11.00	10.20	8.82	7.72	6.83	6.11

TABLE II. VALUES OF SECTION MODULUS FOR ONE LINE OF RIVETS WHEN PITCH EQUALS UNITY

Number of rivets	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Section modulus	1	2	10/3	5	7	28/3	12	15	55/3	22	26	91/3	35	40	136/3

Note.—For any pitch p, the section modulus equals p times the tabular value.

The following is an example in the use of the tables:

Required to support a load of 20,000 lbs. (W) on a bracket; the eccentricity is 15 in. (L), and ¾-in. rivets having a safe stress of 10,000 lb. per sq.in. are to be used. The rivets are in single shear, with a pitch (p) of 3½ in. The safe value of each rivet is, therefore, 4400 lb. (v). Divide the load by this value,

$$\frac{20,000}{4,400} = 4.54 = C$$

In the table under L = 15, pitch = 3½ in., the nearest coefficient to 4.54 is found to be 4.66, which corresponds to 11 rivets, the required number for this design.

If the bearing value of the rivet governs, as in the case of double shear, the value of each rivet is 7500 lb., and we have $\frac{20,000}{7,500} = 2.67$. The coefficient in the table nearest this is 2.64, corresponding to eight rivets, but as this would give a stress slightly in excess of that allowed, nine rivets with a coefficient of 3.26 should be used.

Coefficients of intermediate values of L or p may be obtained with sufficient accuracy by interpolation.

The tables and foregoing discussion apply strictly to one row of rivets, but the same principles may be extended to include groups of rivets containing two or more rows. In this case Sm will not act in a direction normal to the line of rivets, but at an acute angle with it, depending on the pitch of rivets and spacing of the rows. The stress Sr, therefore, becomes a function of this angle. (See Fig. 2.)

Let θ be the angle which Sm makes with the horizontal. Then,

$$(Sm \sin\theta + Sd)^2 + (Sm \cos\theta)^2 = Sr^2$$

and by the same reasoning as before,

$$\left(\frac{vCL\sin\theta}{M} + \frac{vC}{n}\right)^2 + \left(\frac{vCL\cos\theta}{M}\right)^2 = v^2$$

from which we get,

$$C = \sqrt{\frac{M^2}{L^2 + \frac{L}{n}2\sin\theta M + \frac{M^2}{n^2}}} \qquad (6)$$

For more than one row of rivets the expression for M in terms of vertical and horizontal pitch becomes too lengthy to be given here, and moreover the equation (6) is not so readily adapted to slide-rule computation. The method shows, however, how tables for two and three rows of rivets might be made.

An Artificial Respiration Apparatus for restoring victims of gas poisoning or electric shocks is described in a recent issue of the "Engineering and Mining Journal." While not as convenient in use as the "pulmotor" described in our issue of April 6, 1911, it has the advantage of being mechanically simpler and requires no supply of compressed oxygen.

It consists of a metal frame hinged at one end of a board. The patient is placed on his back on the board with his wrists strapped to the frame. A broad leather pad or girdle is placed across the lower part of the patient's chest and held there by small wire cables running through pulleys to the frame. The operator then swings the frame up and down on its hinges, at the same time holding with one hand the patient's tongue. The frame draws the patient's arms with it and also produces pressure on the lower part of the chest at the proper point in each stroke by means of the pad and cables. Thus one operator can correctly perform the movements of the Sylvester method of inducing respiration with less effort than three working without the apparatus.

The device is known as the Synchron apparatus, and is the invention of Dr. Fries, a Swedish physician. The "Journal" states that at the Royal Hospital, Stockholm, this apparatus proved successful in several cases of asphyxiation after manual treatment had been abandoned as hopeless. It is being put on the market in this country by A. E. Sylven, 29 Broadway, New York.

Diagram for Determining the Pitch of Rivets in Plate Girders

By Edward C. Dilworth*

In deck plate-girders the end pitch in rivets per foot is found by the formula,

$$p = 12 \div \frac{r}{\sqrt{\left(\frac{S}{d}\right)^2 + a^2}}$$

where

r = Shearing value of one rivet;
S = Maximum end shear;
d = Effective depth of the girder in inches;
a = A constant equal to the concentrated vertical load per inch length, as determined from conditions or assumptions, e.g., one wheel load distributed over three ties;
476 for Cooper's E 40 loading; ($a^2 = 226{,}580$)
595 for Cooper's E 50 loading; ($a^2 = 354{,}000$)
715 for Cooper's E 60 loading; ($a^2 = 511{,}230$)

The diagram Fig. 3 is based on the assumption that the total shear may be represented by a parabola whose vertex is at the right-hand end of the span, or

$$y = \frac{S\,(l - x)^2}{l^2}$$

where S is the total end shear and l is the span.

On a vertical line through the right-hand end of the span, or the vertex of the parabola, is laid off a scale repre-

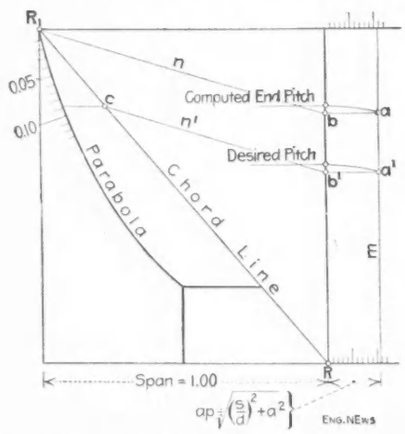


Fig. 2. Diagram Showing Method of Determining Pitch in Deck Plate-girders

senting rivets per foot (or pitch of rivets, depending on the way the scale is graduated), starting from the horizontal line through R.

To the right of R, to the same scale divided decimally, is a horizontal scale. Circular arcs with R as a center are drawn through the rivet scale until they intersect the vertical scale, which is made long enough to include all possible values of

$$ap \div \sqrt{\left(\frac{S}{d}\right)^2 + a^2}$$

To use the diagram, first compute the end pitch in rivets per foot. Referring to Fig. 2, locate a point on the horizontal scale to the right of R equal to

$$ap \div \sqrt{\left(\frac{S}{d}\right)^2 + a^2}$$

(due to the wheel load on the top flange). The quantity

$$\sqrt{\left(\frac{S}{d}\right)^2 + a^2}$$

has already been found in computing the end pitch. From the point thus found draw a vertical line m; from a point a where the circular arc through the computed end pitch found on the vertical scale meets the line m, draw a horizontal line to the vertical scale, locating the point b. Connect b and R_1 with a straight line n.

For the point where any desired pitch begins in the girder, follow the circular arc through this pitch to the line m, and from this point a', draw a horizontal line as before to the vertical scale, locating b'. From b' draw a line n' parallel to n, cutting the chord of the parabola at c. A horizontal line from c to the parabola gives the decimal part of the span at which the desired pitch begins.

In practice the only line that it is necessary to draw is m. The required pitch at any point on the span may, of course, be found by reversing the process.

The following problem will illustrate the use of the diagram: Given a deck plate-girder 62 ft. long, or 60 ft. c. to c. of bearings; maximum end shear S = 280,000 lb.; d = 60 in.; r = 9200 lb.; a = 715. The end pitch is determined as 6.15 rivets per ft.

$$ap \div \sqrt{\left(\frac{S}{d}\right)^2 + a^2} = \frac{715 \times 6.15}{4725} = 0.93$$

From the diagram Fig. 3 we have:

2½-in. pitch begins at 0.121 × 60 = 7.26 ft. from the center of bearing.
4-in. pitch begins at 0.318 × 60 = 19.08 ft. from the center of bearing.
6-in. pitch begins at 0.460 × 60 = 27.6 ft. from the center of bearing.

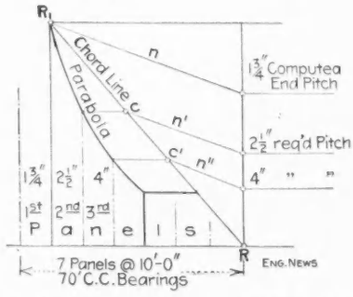


Fig. 3. Diagram Showing Method of Determining Pitch in Through Plate-girders

In the case of through plate-girders, the pitch in the end panel in rivets per foot =

$$12 \div \frac{rd}{S}$$

where r, d and S stand for the terms as previously used. In this case the quantity

$$ap \div \sqrt{\left(\frac{S}{d}\right)^2 + a^2}$$

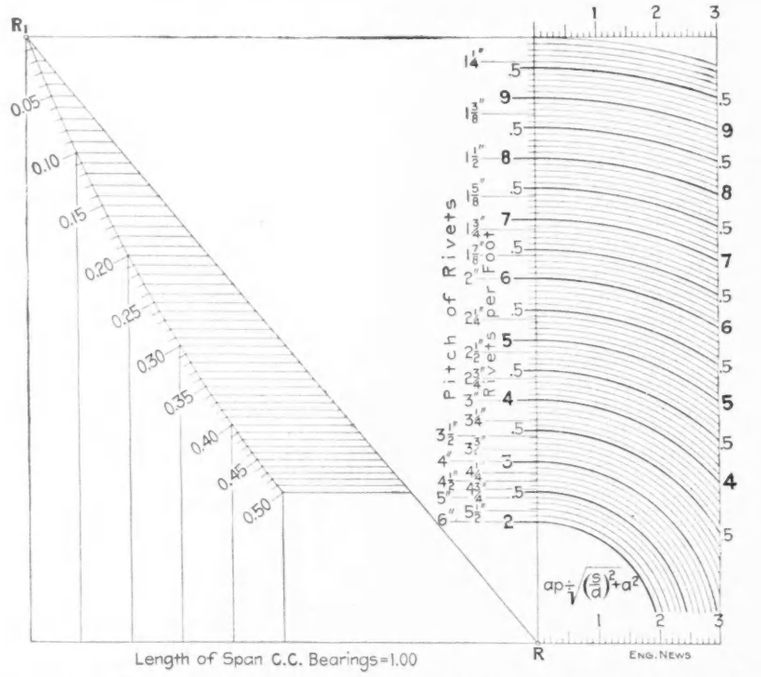


Fig. 1. Diagram for Determining the Pitch of Rivets in Plate-girders

*1422 Frick Building, Pittsburg, Penn.

is omitted and the vertical-pitch scale is used directly. Referring to Fig. 2, consider the end R_1 of the diagram as the first panel-point from the left-hand end. Draw the line n connecting the computed pitch in the end panel in rivets per foot on the vertical scale with the point R_1. The required pitch in each panel may then be found by drawing a horizontal line from the panel point on the right of the panel (on the parabola) to the chord (of the parabola), drawing from this point a line parallel to n will give the required pitch on the vertical scale.

The Weight and Expansion of Excavated Earth

(From a contractor's notebook.)

On the weight of earth there is a lack of definite information. Many of the figures in sight are for more or less loose earth, with no information as to how the material is handled or measured, and in other cases the weight is given without a hint as to whether the figures apply to earth in the pit, or after excavation.

Many experiments are needed before the last word can be said on the different kinds of earth under different conditions —in the pit, freshly cast out, shoveled into barrows, cast into wagons, dry, damp, wet, etc. The wetness seems to have much to do with it. Twenty per cent. of water added to an earth which when "dry" weighs 3200 lb. per cu.yd., raises the weight to 3800 lb., and it seems probable that the voids in "dry" earth in place, especially in soil near the surface, will often admit of the addition of more than 20% (by weight) of water.

The following notes are taken from the original records of some tests made by the writer with pits of 20 cu.ft.:

In 12 cases we got 2994 to 3330 lb. per cu.yd. "in place," with an average of 3186 lb., for earths which were called "dry" or "damp" and were thought to belong in classes No. 1, No. 2 and No. 3. No. 1 earth was not obviously the lightest and No. 3 the heaviest of these, and it is suspected that while there may be such a relation it will be obscured by small differences in the percentage of moisture until experiments more scientific take note of that factor.

One case gave 3522 lb. per cu.yd. for a "dry" earth, which consisted of sharp gravel with about one-third cobble and some clay.

In two cases more the weight per yard was 3726 and 3761 lb. The material here was mostly a dense mixture of red clay and gravel, plastic and moist-to-saturated. The groundwater was close to the surface.

In 12 cases the earth, as fast as picked, was shoveled—rather gently, perhaps—into a 4-cu.ft. box on platform scales alongside, showing expansions, when so handled, of 46% to 69%, average 56¾%.

In one case "soft rotten rock" picked and cast out of a trench 5 ft. wide by 2½ ft. deep by 16 ft. 2 in. long, and reshoveled into carefully measured, straight-sided struck barrows holding 3.4 cu.ft. each, showed 54.8% expansion. No weights were taken.

In four cases earth from 20-cu.ft. pits was, after picking, cast 5 or 6 ft., as if into a wagon, into a box 3 ft. wide by 2 ft. deep by 5 ft. long, leveled and measured, showing expansions 31 to 37%, average 34%. These pits were alongside of four others previously mentioned, in which the expansions in the 4-ft. box were 46 to 56%, average 51¾%.

In one case where the 20-cu.ft. pit was in the gravel mixed with cobble and clay previously described, the expansion in the 30-ft. box was 28% only.

Summary

In the light of the foregoing, the following tentative approximations can be drawn for ordinary earth, "dry" or "damp" (from which perhaps 5% or 10% could be stove-dried—it is probably never quite dry in the pit), picked and shoveled by hand, no distinction being made between earths of the different classes:

	Weight per cu.yd., lb.	Expansions	Pit meas. in per cent. of loose meas.
In place, pit measure.	3200*		
Freshly loaded, in wheelbarrows.....	2100	50%†	66%
Freshly loaded, in wagons	2400	33%	75%
Freshly loaded, in 3- or 4-yd. car.....	2500	30%‡	80%

*It is thought the same earth "wet" may weigh 10 to 20% more, and that even a "dry" earth containing many cobbles may reach 3600 to 3700 lb.

†Expansion put at only 50% because the 4-ft. box of the tests was loaded rather gently; but the large size of the box, in comparison with a barrow, would partly correct the results. Earth spaded and cast in clods will expand more, when measured in barrow or bucket. When part of it was so handled, pit measure was found to be only 63.4% of the water measure of heaped 5-ft. buckets—on a record of 9000 trains of six buckets each.

‡This is for hand loaded cars. When small cars are loaded by steam shovel . . . another story.

Comment

In view of the ancient error surviving in the books unto this day, it is hoped someone may be led to dig for definite information on a yard of earth. Experimenters should determine the percentage of water in their specimens, say by stove-drying 50 lb. and reweighing, and should describe the earth so that those familiar with the art may recognize it. Parallel tests should be made loading into boxes of barrow size (say 3 cu.ft.), casting into wagon-beds (of say 30 cu.ft.), etc.

Photographic Reproduction of Tracings —The article by Mr. Gilkinson in our issue of Feb. 22 on this subject is now supplemented by M. B. Parsons, Assistant Engineer, Office of the City Engineer, Syracuse, N. Y., who describes the methods used there as follows:

As an advocate of this means of reproducing drawings, I will briefly describe the methods used in the various engineering departments of the city of Syracuse.

We make all drawings on a standard size tracing 18x24 in. All lines are drawn rather heavy, and no lettering or dimension figures are less than ⅛ in. high. These tracings are photographed on 6½x8½-in. plates, thus giving photographic reproductions one-third the original size of the drawings, which are easily legible. Like Mr. Gilkinson, we photograph the tracing by transmitted light by placing it in a frame in a window. The frame is the size of the window and is covered with heavy cardboard, leaving an opening slightly larger than the border line of the tracing. The camera used has a long-focus lens (one part of a convertible), which permits placing it farther from the tracing and gives a better image than the ordinary camera lens. Good results can be obtained with even a cheap lens if a small shutter opening is used. Care should be taken to avoid opening and closing doors or windows while the exposure is being made, as this is apt to jar the tracing and cause the lines to be blurred on the negative.

As a guide to timing the exposure, I have found the following very reliable: After focusing, gradually close the shutter diaphragm down until the lines are barely visible on the ground-glass screen. With this strength of light an exposure of 45 to 60 seconds will be about right. We have had splendid results from Seed's "Process Plates," which are especially adapted to this kind of work. The plates are developed with Eastman's hydrochinon developer. For prints we use a good grade of blueprint paper cut 6x9 in. at the factory.

Some of our contract plans consist of upward of 70 separate sheets each, and by reducing the size, we can send a complete set of plans and a book of specifications to out-of-town contractors at the small expense of 4 or 6c. for postage. Our specifications are printed and bound in the same 6x9-in. size. The main advantage, of course, is the convenience with which small size drawings can be carried about in the field. While constructing our second Skaneateles conduit and high-service system, the work was scattered over 23 miles, yet I do not recall an instance, while making inspections of the work, when the engineer in local charge, and the contractor, did not have their plans and specifications with them in the field for ready reference. For all important contracts we bind the prints in heavy paper covers, using cords or binding tacks.

An important item in the cost of a set of tracings for reproduction purposes is the one of titles, which must be made fairly large and heavy. We have adopted a method of taking the tracings to a printer and having the titles printed, using a thickened printers' ink.

Athletic Pigeons on the Horizontal Bar —Riggers and erectors are cautioned to note the happening described in the following communication, whose author lacked the courage to sign it:

While a 50-ton steel girder, the second largest ever delivered in New York City, was being lifted from the truck by a derrick at the new Blank Building, New York City, a flock of pigeons lighted on one end. The girder had been perfectly balanced, but the birds tilted down the end on which they lighted, and it took the workmen an hour to get the enormous piece of steel level again and into final position.

Letters to the Editor

The Deterioration of Cast-Iron Water Mains

Sir—In your issue of Feb. 8 (p. 257) I note a letter on the "Deterioration of Cast-Iron Water Mains." The waterworks system in this place was constructed in 1881. The pipe was of ordinary manufacture and coating, with only ordinary inspection when unloading. Pressure from about 75 to about 60 lb. at present. The water is taken from a storage reservoir on a small stream and is quite soft. At present and for about eight years it has been filtered.

About a year ago the 12-in. main was broken for a new connection. The exterior was in perfect condition and the interior was almost as good. There was practically no tuberculation and only a few small rust spots the size of large pin heads, but of no appreciable depth.

Many other like connections have been made in various parts of the system in recent years, and in all cases the pipes have been found in equally good condition.

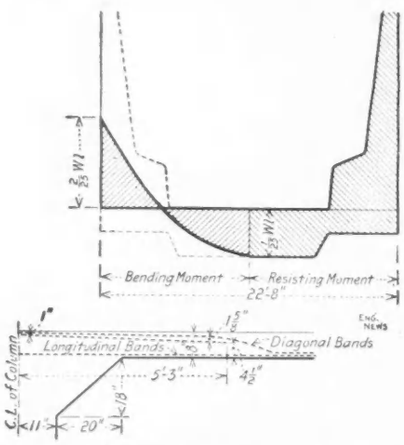
E. F. MUSSON,
Engineer, Norwich Water Works.
Norwich, N. Y., Feb. 28, 1912.

The Designer's Defense of the Design of the Collapsed Prest-O-Lite Reinforced Concrete Building at Indianapolis

Sir—It is the intention of this article merely to protect this design from any unjust criticism which may have resulted from recent articles in ENGINEERING NEWS, and not to prove any design herein referred to as incorrect. To be fair to the writer of the above mentioned articles,* I wish to say that he was at a disadvantage in that he did not have all the facts. I do not think, however, that he was justified in criticising so severely and jumping so readily to conclusions upon a matter upon which he appeared to have such meager information. An engineer who would endeavor to place the blame for such a disaster as the Prest-O-Lite collapse should be both fair-minded and unprejudiced, and should feel fully his responsibility before giving out to the engineering world any conclusions which unjustly endanger the standing of any man or men. Since I was in close contact with both the architect and the contractor during the construction of this building, I am in a position to know most of the facts, and I wish to take this opportunity to present them to the readers of this paper.

There are so many systems of flat-slab design being erected successfully, with such widely different quantities of steel and concrete in them, that it is impossible to fix an absolutely rigid method for such design. The differences depend mostly on the assumptions upon which the different designers base their designs.

In a paper read before the National Association of Cement Users, Feb., 1910,



MOMENT DIAGRAM FOR COLUMN HEAD OF SECOND FLOOR; PREST-O-LITE BUILDING

and published in ENGINEERING NEWS, March 31, 1910, Mr. MacMillan made a comparison between the different methods of figuring these designs. Both the systems as proposed by Mr. Condron and that of Taylor & Thompson are very similar to the one called the Cantilever Method in that article. Both assume that the slab will act as a flat plate over the column limited by a line of inflection, with the remainder of the slab acting as a load uniformly applied along this line of inflection. This method is then entirely dependent upon the position of the line of inflection.

According to the paper referred to above, both MacMillan and Turner base their designs upon Grashof's analysis of a flat plate supported at four points. Owing to the fact that this analysis is derived for a flat plate of homogeneous material which takes stress in every direction, some authorities contend that it is not applicable to reinforced-concrete slabs. But, since the exact stresses in flat slabs are theoretically indeterminate, such a contention cannot be accepted until proved by actual test, which is the only reliable authority on this subject.

Both Turner and MacMillan floors have stood such tests in a creditable manner, which seems to prove that Grashof's analysis when applied to a reinforced-concrete slab is not entirely incorrect. My design is also based on Grashof's analysis and is figured in a manner very similar to that recommended by MacMillan. Whereas Grashof's analysis would allow a moment of $^1/_{30}$ *WL* in the center of the slab and $^1/_{25}$ *WL* over the column, I used $^1/_{25}$ *WL* in the center of the slab and $^2/_{25}$ *WL* over the column. *L* as used in this formula is the longer span of the rectangular panel.

DESIGN

The true design is as follows:

Second floor:

Panel	21 ft. 6 in. x 22 ft. 8 in.
Span	22 ft. 8 in.
Rough slab	8 in. thick
Live load	250 lb. per sq.ft.
Dead load	113 lb. per sq.ft.
Total load	363 lb. per sq.ft.
Area of panel	487 sq.ft.
Area over column head	27 sq.ft.
Effective area	460 sq.ft.

$$M = \frac{460 \times 363 \times 22.67 \times 12}{25} = 1{,}820{,}000$$

$$A = \frac{M}{0.88 \times d \times fs} = \frac{1{,}820{,}000}{0.88 \times 7 \times 18{,}000} = 16.3$$

$$\frac{16.3}{4} = 4.07 \text{ sq.in.}$$

I used sixteen ½-in. square bars; area, 4 sq.in.

Note that the steel used in the slabs was new medium cold-twisted and was figured at 18,000 lb. per sq.in.* This steel has since been tested and found to have an elastic limit of about 61,000 lb. per sq.in.

Third floor:

Panel	21 ft. 6 in. x 22 ft. 8 in.
Span	22 ft. 8 in.
Rough slab	7 in. thick
Live load	150 lb. per sq.ft.
Dead load	87 lb. per sq.ft.
Total load	237 lb. per sq.ft.
Area of panel	487 sq.ft.
Area over column head	24 sq.ft.
Effective area	463 sq.ft.

$$M = \frac{463 \times 237 \times 22.67 \times 12}{25} = 1{,}200{,}000$$

$$A = \frac{1{,}200{,}000}{0.88 \times 6 \times 18{,}000} = 12.6$$

$$\frac{12.6}{4} = 3.16 \text{ sq.in.}$$

I used sixteen $^7/_{16}$-in. square bars; area, 3.06 sq.in.

*Mr. T. L. Condron in Engineering News, Dec. 28, 1911, and Jan. 11, 1912.

*The figure originally furnished to us and given in the statement submitted to Mr. Baker, was 16,000 lb.—Ed. Eng. News.

As the moments used are practically the same as those for a beam fixed at the ends, I assumed that the moment diagram for one panel would be a parabola. By plotting the bending moment diagram I found that it was only necessary to carry the diagonal bands to the top of the slab at the column in order to provide sufficient resisting moment. To provide a greater factor of safety I placed spider bars in the top of the slab at the column which in the moment diagram [shown in the accompanying cut] were figured to resist only as much tension as they would develop by virtue of their bond with the concrete. As these were designed to be in the top of the slab they could certainly be figured as effective tension area to this extent. This would then give a resisting moment at the edge of the column head of $\frac{1}{20}$ *WL* instead of $\frac{1}{25}$ *WL* as stated in the criticism.

By reducing my design to a 20x20-ft. panel and figuring the steel at 16,000, it can be fairly compared with those of Turner, MacMillan, Taylor & Thompson, and Condron, which were figured with the same conditions. The results thus obtained are given in Table I. By comparing the results it is easily apparent how Mr. Condron obtained such high stresses in the steel as I used it. However, it also follows that if he had applied his method of design to any of the other designs tabulated he would have obtained stresses nearly equal to those he obtained for my design. Therefore, since floors designed by Turner's or MacMillan's method are undoubtedly safe, it is a question whether a flat-slab design can be fairly criticised by applying, without regard to any assumptions the designer may have used, another method of flat-slab design. This method of criticism appears to be especially questionable when such an overconservative design as Mr. Condron's is used for a basis of comparison.

Some points in Mr. Condron's design are conservative to such a degree that any balanced design would compare unfavorably with it. Under the circumstances, I do not feel it necessary to take up the design as criticised by Mr. Condron in detail. I would simply call attention to a few of the most glaring points. For example—in what he calls the designer's method he uses a mean span of 26 ft. MacMillan's article, to which he was referred by the writer, states plainly that *L* is the longer dimension of a rectangular panel. The true figure is 22 ft. 8 in. The Cleveland building ordinances would allow a mean of the two dimensions, which would be 22 ft. 1 in.

He also states that he would use $\frac{1}{8}$ *WL* as the bending moment between column heads, when in reality $\frac{1}{24}$ *WL* could be used and is recommended as conservative by Taylor & Thompson. Another point open to question is his assumption that the line of inflection is at a distance of $\frac{1}{4}$ *L* from the column center. This point is always at a distance of $\frac{1}{5}$ *L* from the support in the case of a beam as usually figured for fixed ends and the latter figure is also recommended by MacMillan. By figuring the actual stresses by Taylor & Thompson's method, my method, and my interpretation of Mr. Condron's method, I obtained the results which are given in Table II. I used the loads used by Mr. Condron so that my table can be compared with his Table II [ENGINEERING NEWS, Dec. 28, 1911].

The computations for the different designs are as follows:

WRITER'S DESIGN

Using the same dimensions as given in the above computations, but with $M = \frac{WL}{20}$

Second floor:

Total load ..... 300 lb. per sq.ft.
Effective load ..... $460 \times 300 = 138{,}000$ lb.

M (at critical section) =
$$\frac{138{,}000 \times 22.67 \times 12}{20} = 1{,}880{,}000$$

$$A = \frac{M}{0.88 \times d \times fs} \text{ or } fs = \frac{M}{0.88 \times d \times A}$$

$d = 8 - 1 = 7$ in.

A (slab) ..... 16 sq.in.
A (spider) embedded 32 in. beyond critical section; hence
Effective area $= \frac{32 \times 3.14 \times 80 \times 8}{16{,}000}$ .. 4 sq.in.

Total effective area ..... 20 sq.in.

$$fs = \frac{1{,}880{,}000}{0.88 \times 7 \times 20} = 15{,}300 \text{ lb. per sq.in.}$$

Assuming total load ..... 350 lb. per sq.ft.

$$fs = \frac{350}{300} \times 15{,}300 = 17{,}580 \text{ lb. per sq.ft.}$$

Third floor:

Total load ..... 175 lb. per sq.ft.
M (at critical section) =
$$\frac{463 \times 175 \times 22.67 \times 12}{20} = 1{,}105{,}000$$

A (slab) ..... 12.25 sq.in.
A (spider) effective area
$$\frac{34 \times 3.14 \times 80 \times 8}{16{,}000}$$ 4.27 sq.in.

Total effective area ..... 16.52 sq.in.

$$fs = \frac{1{,}105{,}000}{0.88 \times 6 \times 16.52} = 12{,}700 \text{ lb. per sq.in.}$$

Assuming total load ..... 238 lb. per sq.ft.

$$fs = \frac{238 \times 12{,}700}{175} = 17{,}300 \text{ lb. per sq.in.}$$

TAYLOR & THOMPSON'S METHOD

Mr. Condron's interpretation of Taylor & Thompson's design, which I repeat below, was correct except that when he figures the actual stress in the steel he uses 22.24 as the area and 16,000 as the allowable stress. The unit stress allowed was 18,000. Making the correction in the area to take care of this difference, gives an area of slab bars of 19.1 sq.in., which, plus the effective area of spider bars, gives a total effective area at the critical section of 23.1 sq.in. instead of 22.24 as figured by Condron's method of including spider bars as effective. With this change and assuming the effective depth as 7 in. instead of 6.75, my computation by Taylor & Thompson's method gives the figures shown in Table II.

CONDRON'S METHOD

Second floor:

Assume line of inflection at a distance of one-fifth from center of column.

$$\frac{22.67}{5} = 4.53 \text{ ft.}$$

Total area o panel ..... 487 sq.ft.
Area inside line of inflection 9×9 .. 81 sq.ft.
Area outside line of inflection ..... 406 sq.ft.
Total load ..... 300 lb. per sq.ft
$M = (300 \times 406 \times 1.92) + (300 \times 55 \times .096) =$ 249,800 ft.-lb.

$$fs = \frac{249{,}800 \times 12}{20 \times 0.88 \times 7} = 24{,}200 \text{ lb. per sq.in.}$$

With total load ..... 350 lb. per sq.ft.

$$fs = \frac{350}{300} \times 24{,}200 = 28{,}200 \text{ lb. per sq.in.}$$

Third floor:

Total load ..... 175 lb. per sq.ft.
$M = (175 \times 406 \times 1.92) + (175 \times 55 \times 0.96) =$ 145,250 ft.-lb.

$$fs = \frac{145{,}250 \times 12}{0.88 \times 6 \times 16.52} = 20{,}000 \text{ lb. per sq.in.}$$

With total load ..... 238 lb. per sq.ft.

$$fs = \frac{238}{175} \times 20{,}000 = 27{,}200 \text{ lb. per sq.in.}$$

By comparing the values in Table II it appears that my interpretation of Mr. Condron's design is more nearly correct than his own in that the stresses check more closely to those of Taylor & Thompson's method which is a parallel design.

The conclusion that the failure might have resulted because of the steel being stressed to 35,500 lb. per sq.in. and therefore beyond the elastic limit is absurd because, granting that it were possible to get such a stress (as shown above the writer gets 24,200 lb. per sq.in.) the slab steel used was cold-twisted and by actual test showed an elastic limit of 61,000 lb. per sq.in.

The actual load on the second floor at the time of failure was in reality closer to 360 lb. per sq.ft. than 300, as stated by Mr. Condron. The load was divided as follows:

Second floor slab	113 lb.
Third floor slab	87 lb.
Roof slab	75 lb.
Cinders on the roof	32 lb.
Pipe on second floor	35 lb.
Forms on second and third floor	15 lb.
Shavings, etc., on second and third floor	5 lb.
Total load	362 lb.

Mr. Condron also states in his article that, "All observers of the wreckage seem to agree that the concrete of the second floor had set and attained its normal strength." Where he gets the authority for this statement I do not know, as actual tests entirely disprove it. The tests which gave the results as tabulated in Table III were made by a testing laboratory of unquestionable standing upon samples which they took from the wreckage and retained 7 days in 70° temperature while being prepared for a test. These results then can certainly be considered as far above the maximum at the time of failure, as such treatment would strengthen the concrete to a marked degree. It can be seen that the concrete from the Prest-O-Lite building is far below standard. An unofficial yet reliable report upon a test made on the concrete at the time of failure gives a compres-

sive strength of about 1000 lb. per sq.in. Using this value, the concrete is then only about 40% strong.

The testimony of witnesses, the position of the wreckage and the opinions of experts on such matters agree that the failure did not occur in the second-floor slab, but was probably due to the displacement of shoring under the third-floor or roof. Then the second-floor slab, although less than 50% strong, was carrying a load greater than the design load. Evidently, then, the design was not grossly in error, as it would have supported a load greater than twice the design load if the concrete had been 100% strong.

There are a few facts in connection with the letting of this contract which ought to be known on account of the remarks made by Mr. Condron's article. The design as put out by the architect for bids was for a beam and girder type. They called for an alternate design of a flat slab. I submitted both types of design, the flat-slab type being accepted. The contractor agreed to furnish both more concrete and more steel in the flat-slab design than was called for in the architect's design. Mr. Condron's statement that "Danger attends the practice of letting contracts for buildings based on alternate designs, the main object of which is to use less material than other contractors have estimated on," is, therefore hardly relevant.

Now, consider the above in connection with the following facts and draw your own conclusions as to the designer's responsibility.

The amount of slab steel used compares favorably with that used in other buildings of this type, and by test shows an elastic limit of over 60,000 lb. per sq.in. The slab thickness also compared favorably with that used in many buildings of flat-slab design which have been tested and shown to be satisfactory.

The concrete in the roof had no strength, the concrete in the third-floor slab was not strong enough to stand a test, although 23 days old, and the concrete in the second-floor slab, although 44 days old, was only good for an ultimate compressive stress of 1000 lb. per sq.in.

The forms under the second-floor slab were removed completely on the 21st day after it was poured, the third-floor slab having been poured about three days before. The mean temperature from the time the second-floor slab was poured until the failure was 38°. The temperature was never continuously above 55° for 24 hours; no salamanders were ever used under this slab, and the material had not been heated. The slab was 8 in. thick with 1 in. finish put on immediately, which undoubtedly retards the setting of the mass; but being hard itself, fooled the contractor.

At the time of the failure this slab was carrying 260 lb. per sq.ft. superimposed load concentrated on points 4x5 ft. centers, as stated before. A few 4x4-in. shores, 16 ft. long, unsupported laterally, had been put in, but the trenching for sewers and plumbing in the center of the panels makes it a matter of question where they were.

Nevertheless, regardless of the above conditions, I do not believe that this slab failed, for the following reasons:

The position of the wreckage indicated a failure from above with impact on the second-floor slab which, in its overloaded condition, could not have been expected to withstand a shock.

There were carpenters, laborers, plumbers and probably other craftsmen working in the second story. They were carrying their materials, piling or placing them, and it would, of course, be very hard to work around with pieces of scantling or pipe over 20 ft. long between the shores on 4x5-ft. centers braced both ways with cross ribbands. These men were undoubtedly ignorant of the danger of disturbing the shores. The shoring was so designed that while perfectly capable of carrying the dead weight placed on it, yet lacked cross-bracing and stiffness if disturbed in any manner.

The grand jury, who were at the site within a few hours after the failure, examined witnesses and concrete experts. Their report follows:

> On the afternoon of Dec. 6 the grand jury received notice that a reinforced-concrete building which was being erected in the rear of the Prest-O-Lite building, on East South street, had collapsed. The members of the grand jury immediately went to the scene of the wreck and commenced a personal investigation. On the same day we submitted certain recommendations to this court and asked that an order be made that all reinforced-concrete construction be stopped by the city building inspector. In the course of a week we commenced an investigation. All the witnesses have been heard, including men who were employed on the building, and also experts in concrete construction work. At this time we submit to the court the result of our investigation:
>
> 1. There is no violation of the criminal laws.
>
> [The second item is a comment about the lack of laws governing concrete construction work.]
>
> 3. We are of the opinion that the cause of the collapse was the removal of some form supports from the concrete before it had fully set. We feel that an ordinance should be passed governing this point; a law giving some one authority to say when forms should be removed.
>
> 4. The weather conditions during the months of October and November were the worst known in years for concrete work.

In the light of the above and the fact that the second-floor slab when it did fail, failed in shear, as shown by the wreckage, there being plenty of concrete to resist shear at all points, there can be no reason for splitting hairs over points in design on which eminent engineers are at variance unless it be by some one seeking to gain material advantage for himself.

HUGH J. BAKER,
(Representing Olney J. Dean & Co.)
Indianapolis, Ind., Feb. 23, 1912.

TABLE I

COMPARATIVE SIZES OF DIFFERENT FLAT-SLAB DESIGNS

	Turner	MacMillan	Condron	Taylor & Thompson	Baker
Size of panel, ft.	20x20	20x20	20x20	20x20	20x20
Size of column, ft.	5x5	5x5	5x5	5	5x5
Live load, lb. per sq.ft.	200	200	200	200	200
Thickness of slab, in.	8	8	8	9.5	8
Area of steel per band, sq.in.	1.50	2.99	5.16	2.45	2.86
Area of slab steel over column, sq.in.	12.0	23.92	41.28	21.90	11.44
Area of spider bars, sq.in.	.....	.....	.....	.....	6.28
Total area over column, sq.in.	21.20	31.36	41.28	21.90	17.72

Note.—Total area over column in Turner and MacMillan's method taken from Condron's Table I.

TABLE II

	Second floor			Third floor
Load, lb. per sq. ft.	350	300	238	175
	Stresses in lb. per sq.in.			
*Baker (Condron's interpretation)	16,100	13,800	15,500	11,400
Baker (my interpretation)	17,850	15,300	17,300	12,700
Taylor & Thompson	25,600	22,000	28,800	21,200
Condron (my interpretation)	28,200	24,200	27,200	20,000
Condron (his own interpretation)	41,500	35,500	39,700	29,200

*Inserted from Eng. News, Jan. 11, 1912, p. 69, by Editor, Eng. News.

TABLE III

Sample	Lb. per sq.in.	Age
Second floor slab	1635	55 days
Second floor columns	1375	34 days
Third floor columns	432	15 days

The Pittsburg Sewage Purification Order: Letters from Commissioner Dixon and Mayor Magee

Sir—The editorial in your issue of Feb. 29, entitled "A Plea for Common Sense in State Control of Sewage Disposal," is timely and important and should be preserved for future reference by every officer engaged in administering law relative to state control of water supplies and sewage-disposal works. While it appears to bear pretty heavily upon the Pennsylvania Department of Health, that department welcomes criticism calculated to result in a better general understanding of the methods by which Pennsylvania laws respecting the purity of state waters are being executed. This is important because of the fact that evidently the engineering world does not have a correct understanding of these methods.

The Pittsburg sewage problem cannot be properly discussed at present because the deliberations of the city authorities

have not been concluded, so far as the department is informed. In good time the results and reports of the experts temporarily employed by the city will reach the state authorities.

However, there are other important questions raised, perhaps in the minds of sanitary authorities throughout the country, by the editorial, that I would like to touch upon for the good it may do.

(1) Instead of arbitrary methods, cooperative effort has been the rule of action, offered and largely accepted, during the seven years of central control of public health affairs in Pennsylvania. With perhaps a half dozen exceptions, no municipality has appealed from any decision of the Commissioner of Health, Governor and Attorney General relative to water-works and sewerage, and no appeal whatever has been carried through the courts, although hundreds of decrees have been issued. Hearings and conferences at Harrisburg are of daily occurrence; the office is open for consultation and advice; engineers are sent out to confer with local authorities in the field and no reasonable effort is spared in little or big matters to save a town, or corporation, or individual from unnecessary trouble or expense on account of state policies; but the advantages offered must be sought. These methods are appreciated very generally throughout Pennsylvania, but they may not be understood beyond the state.

(2) Regarding the point that thoroughgoing engineering study of prevailing conditions should be made prior to the issuance of a decree ordering preparation of plans, I submit that this is a debatable question to be settled by public policy in each commonwealth. The Pennsylvania department does not subscribe to the idea that all the engineering should be done by the state. The local engineer must have his field of labor and he needs the aid of the consulting expert on special problems. Such service rendered to the town is a legitimate charge on that town only. In consequence of the department's advocacy of this principle, the class of engineering on water-works and sewerage has advanced in Pennsylvania to the advantage of the taxpayer and the health of the public. Wasteful piecemeal methods of construction regardless of conformity to system is a thing of the past. Sewer systems and water-works are now being built or extended on an economical basis, and one is surprised when he contemplates the magnitude of this great work that is going on unheralded and impossible of achievement without central control. If it is your opinion that extravagant expenditures are enjoined and that towns will be bankrupt by the department's orders, I wish to assure you to the contrary. Experts usually recommend plans the execution of which will extend over a long period of years; but sometimes an immediate outlay is ordered. In one instance of recent date, where the department requested the immediate construction of new sewers and sewage-disposal works, the voters defeated the bond issue. Riparian owners on the stream below, failing to get relief from the state, brought civil action and were awarded damages by the court. Subsequently the citizens of that town ceased to abuse the department and built the works. The borrowing capacity of that municipality has not been exhausted and there is money in plenty for other needs. All decrees of the commissioner that are subject to appeal to the court. Furthermore, bond issues in excess of 2% must be submitted to a vote of the people. So the reins of government have not been wrested from the municipalities of Pennsylvania. The water and sewerage problems work out pretty well and to the satisfaction of the majority.

(3) At this moment, I do not recall any town that has been put to a large expense for making plans that may never be needed. All the plans that I know anything about are being used as a basis for construction year by year. Furthermore, the department never specifies any particular type of works with the possible exception of the sewer. That problem is up to the town engineer who must initiate. The state will make general suggestions and act in an advisory capacity. The field is open to everybody, with no favorites; no engineer is ever recommended; no special apparatus is exploited and no side track is provided for commercial interests. A statement of policy respecting these things was announced early in the department's history and all interest connected with the department's work will testify that this policy has been rigidly adhered to. If the town expert chooses to make elaborate plans for disposal works that may not be built for many years, that is a matter between himself and his client. The department requires sufficient initial study by the town to show that the sewer system will fit in and become an efficient and economical part of a complete system comprising sewers and the concentration of the sewage at such point or points that it can be controlled when the time comes for such control. There will be advancement made in the art of sewage treatment and the state certainly does not want detail plans of treatment works that may not be built for 10 or 20 years; but only such outlines as are necessary to wisely determine what relation the disposal may have to the sewers to be built in the interim. In some cases this study has resulted in the purchase of land in anticipation of the future need. The questions are local and no general rule can be laid down. Surely, engineers will not argue against the Pennsylvania policy of laying out comprehensive systems to be built up to as time goes on. What sane man would build one room of a house before he has planned the entire building? The General Assembly has twice appropriated money for state aid for sewage-disposal works. During four years and in anticipation of such aid, many towns hustled to get their plans approved by the department, but the Governor vetoed each appropriation.

(4) Who is to determine what constitutes "superficial studies of local conditions prior to the issuing of orders" by the state? Some outside authority of eminent standing, or the constituted state and municipal authorities and the courts of the commonwealth? The Pennsylvania department proceeds on the basis respecting stream pollution by sewage that a knowledge of all existing conditions with reference to the use and probable use of that stream above and below the point of sewage discharge, and of the present methods of disposal in the area sewered or to be ultimately sewered, aided by such plans and facts as the town must file in the department's office, supplemented by field investigation and not overlooking the financial status of the municipality, is substantially enough information to determine whether the interests of public health will be subserved by permitting the sewage to be discharged into that stream. The following quotation from the decree of the commissioner, *et al.*, relative to the Saw Mill Run district of Pittsburg, illustrates the point. This decree was agreed upon between the city and state representatives before it was issued:

> If all of the present population in the city and boroughs were to USE existing sewers, the NUISANCES in Saw Mill Run might not be measurably increased, but this will not hold true as the territory develops. It could not be expected in reason that State sanction could be given to a plan for a remedy that did not contemplate and provide for an ABATEMENT of the NUISANCES and against the RECURRENCE of similar NUISANCES in the future when the entire drainage basin shall have become thickly populated.
>
> All but 3 of the 23 sewer outlets hereinbefore mentioned, now belong to the city. That part of the 19th Ward formerly West Liberty borough, is to be provided with a SYSTEM OF SANITARY SEWERS, the plans of which have recently been approved by the State Department of Health and a temporary outlet into Saw Mill Run has been granted.
>
> Other parts of the watershed of Saw Mill Run in the townships and boroughs not yet a part of the city of Pittsburg, will be sewered in the near future in the ordinary course of events and the outlets must be into Saw Mill Run. But UNPURIFIED SEWAGE cannot be permitted to INDEFINITELY DISCHARGE into the stream. Not only must the sewage from these (outlying) districts be subjected to treatment and the pollution and poisonous matter be removed therefrom before the liquids go into the stream, but it is evident, from what has been hereinbefore set forth, that the public health demands the treatment of the sewages now going into the run

from the existing sewer outlets at the EARLIEST PRACTICABLE MOMENT.

It would not be as economical to erect and operate independent sewage purification works AT THE MOUTH OF EACH SEWER, as to intercept the discharge from several or possibly all of the 23 sewer outlets and effect the treatment of all sewages at ONE COMMON PURIFICATION PLANT.

For instance, it would be cheaper and better for Carrick borough and Knoxville borough to discharge their sewages into a MAIN INTERCEPTER to be provided by the city for its own sewage leading to a treatment plant, than for each place to independently erect a treatment plant and pay the cost of separation and maintenance. And this obtains with respect to the townships wherein the land is undeveloped.

Probably in working out the problem for itself the city of Pittsburg will plan a TRUNK SEWER down the valley of Saw Mill Run for the conveyance of SEWAGE ONLY. This structure should be of capacity sufficient to take sewage from the entire basin. This dictates the construction of SEPARATE SEWERS IN THE UNSEWERED DISTRICTS of the territory and the providing of independent drains for the removal of the surface water. The latter need not be extensive, but the former will aggregate a total of many miles of pipes. Certain it is that STORM WATER CANNOT BE TREATED in sewage works with any DEGREE OF ECONOMY. The cost is prohibitive. Furthermore, it would be extravagant and useless to attempt to construct an enormous drain to convey mingled sewage and storm water down the valley. Nature has provided the best kind of a natural course for the runoff of the storm water in the channel of the run itself.

Some coöperation of the city, the boroughs and the townships is necessary in carrying out the plan proposed, and possibly added legislation may be required to enable the project to be executed upon an equitable basis.

In SELECTING A SITE for the treatment of the sewage in question, the proper disposition of the sewage of OTHER DRAINAGE DISTRICTS of the city may be necessarily involved. It is quite probable that the city authorities may bestow attention on and study the entire problem while considering Saw Mill Run sewerage and sewage disposal. However, the matter of ULTIMATE TREATMENT of the sewage NEED NOT DELAY the perfecting of the sewer plans and the construction of new sewers. A complete plan for the collection of sewage from the entire Saw Mill Run basin should be outlined, particularly with respect to the trunk sewer, mains and submains. The scheme should be worked out in its entirety, and it should be permanent and in this form it should be approved by the State authorities and be adopted by the local authorities and thereafter every sewer built should be in conformity with this plan in order to obviate the wasting of taxpayers' money and to secure efficiency.

The STUDY of the treatment of the sewage is necessary because CONCLUSIONS NECESSARILY INVOLVE the location, elevation and size of some of the main sewers. In most every instance throughout the State of Pennsylvania and elsewhere, the plans adopted for the treatment of the sewage very materially affect the plans of the sewers. Frequently expensive changes in the sewers have to be made to adapt the sewer system and disposal works to each other. Both factors in the problem should be considered together in Pittsburg.

The EXISTING SEWERS in Saw Mill Run WILL BE INCORPORATED into the comprehensive sewer system. Some alterations must be made whereby the larger percentage of storm water will be eliminated from the proposed intercepting system for sewage. The 35th Ward sewers MAY OR MAY NOT BE ADAPTED to the comprehensive sewer system, but the interests of the public health demand that they BE APPROVED on the ground that these extensions are in keeping with the policy of the city which has prevailed in the past. However, this policy must stop for the obvious reasons hereinbefore given. The city should provide ample funds forthwith to defray the cost of surveys and plans for a comprehensive sewer system for the Saw Mill Run basin and for the disposal of sewage of the district and of any other district or districts of the city involved in the problem. One year's time should be sufficient for the making of a sewer plan. THE TIME WHEN THE TREATMENT OF THE SEWAGE SHALL BE REQUIRED SHALL BEST BE DETERMINED AFTER THE PRELIMINARY COSTS SHALL HAVE BEEN ESTIMATED AND OTHER MATTERS HAVE BEEN TAKEN INTO CONSIDERATION.

The department assumes the position that such a decree is a sufficiently clear basis upon which experts may work, especially where, as in the Pittsburg case, it is understood and agreed that the city and the state will coöperate thereunder.

Unfortunately, there has been a breach of good faith in the Pittsburg case. I had an understanding with the Chief Executive of Pittsburg and his engineer which has been disregarded. The cooperative methods in vogue in the conduct of the affairs of the department may not be dismissed as immaterial by any individual dealing with a problem imposed by an order of the commissioner without that individual assuming full responsibility for misunderstandings and the consequences thereof. The eminent experts imported by the city have made their reports without consultations with the department. These reports have been handed out to the public press, by whom the department does not know. However, up to this moment there is no issue between the city and the state. The one your editorial and the experts have voluntarily raised is based largely on assumptions. How the Pittsburg decrees could be misconstrued is understood; but why they should have been misconstrued is not understood by us. It is a matter of common sense and decency, of economy and health, patent to everybody who owns property and lives there, that the discharge of sewage and manufactural wastes into the runs and creeks of the Greater Pittsburg district and into the rivers also, needs to be regulated and controlled under some acceptable and settled policy and plan. The department has had this single purpose in view and it believes that such a policy can and will be worked out jointly by the city, the surrounding municipalities and the state.

The original intention with respect to spending the $40,000 city appropriation for investigations, as we understood it, was, that most of this money would be needed for surveys and plans for the internal improvements to be made by the city Bureau of Construction, regardless of what the experts' findings might be as to disposal. Here again we are in ignorance of what has been done. The department ought not to be subjected to ridicule for matters over which it exercises no control. Its confidence has been betrayed and professional ethics have been violated in this instance through the concluding of the investigations and the publishing of the reports without consultations with the department.

And finally, the government of Pennsylvania has decided, after a careful and comprehensive study of the conditions of streams throughout the eastern portion of the continent and particularly of the streams in Pennsylvania, that the future will demand the maintenance of a higher purity of the waters, and that now is the opportune time to start a campaign in order that the streams shall not become stinking sewers and culture beds for pathogenic organisms. Such a campaign will materially reduce the danger of poisoning the people, not only through public water supplies, but in a hundred and one ways, through fish, animal, commercial and other channels.

SAMUEL G. DIXON, Comr. of Health.

Harrisburg, Penn., Mar. 4, 1912.

[The serious points raised by Dr. Dixon as to lack of coöperation, breach of faith, betrayal of confidence and lack of professional ethics on the part of the City of Pittsburg and its expert engineers are ably answered below by Mayor Magee.

As to Dr. Dixon's comments on our editorial discussion he seems to touch only relatively minor points raised by us, leaving almost unnoticed the main question as to whether it is wise for a State Department of Health to try to require every community in the state to prepare plans for sewage purification and to compel so large a city as Pittsburg to construct separate sewers and purify its sewage to a drinking-water standard, all for the questionable benefit of a few thousand people whose water supplies might be somewhat more polluted at times if the sewage were not purified.

It is not sufficient to say that the orders are merely for the preparation of plans, since it would be the height of folly to compel the submission of plans which are never to be executed—particularly such plans as were called for in the Pittsburg case.

Nor did we mean to imply that the state rather than the municipalities should make thorough engineering studies for local sewage purification. Far from it! But if a state takes an ultra-radical stand

on sewage purification it must be prepared to back it up by something besides strong personal conviction and superficial local study; and if a hundred typewritten pages, consisting largely of local data, gathered by the engineering staff of a state department of health, are sent to a municipality in response to simple requests to extend sewers, as in the Pittsburg case, there is some excuse for passing judgment on the character of engineering studies, especially when they are the only apparent scientific basis for orders interpreted to mean the expenditure of fifty million dollars or more.

Finally, we are surprised that Dr. Dixon should write of "experts imported by the city," and more surprised still that he should mention streams as "culture beds for pathogenic organisms." The first statement reminds us of the recent attempts to exclude American engineers from professional practice in Canada and the second is—well, surprising.

MAYOR MAGEE'S REPLY

As we have already stated, Mayor Magee has sent us a reply to Dr. Dixon's letter, which follows below.—ED.]

Sir—My attention has been called to the communication addressed to the ENGINEERING NEWS by the Commissioner of Health of the State of Pennsylvania concerning the recent publication of the reports of Messrs. Hazen, Stearns, Eddy and Sprague, sanitary engineers, upon the question of the collection and disposal of the sewage of the city of Pittsburg. The Commissioner in his comments unfortunately treats the subject as if the mere publication of these reports had brought the question to the stage of controversy and acrimony. It is to be hoped that this aspect of the matter is not nor ever will become dangerous. The problem is too serious to be weighted with personal and public disputes between individuals who are charged with grave official responsibilities and whose authority is in no sense personal, but merely representative.

To prevent the main question from being lost sight of or becoming beclouded in the minds of those interested and for fear that the city may be prejudiced by the acts of its officials or agents whether right or wrong, I feel impelled to reply to some of the expressions of the Commissioner contained in his communication to you. I would not have Dr. Dixon continue to hold the impressions he gives voice to, nor would I let the city be deprived of the coöperation of the State Department of Health in the solution of its sanitary problems when I believe an explanation would help to clear the atmosphere.

Dr. Dixon charges a breach of faith, a violation of professional ethics, a betrayal of confidence. He speaks several times of an "understanding." What these confidential relations and understandings between us were is not stated. I have no recollection of any agreements, understandings or promises whatever. There could have been no violation of professional ethics, for there was no professional relation existing between us; no breach of confidence, for none could have been imposed under the very circumstances of the case. Our relations are purely official, our business is public business and until now has been transacted in the manner provided by law. It could not have been transacted in any other manner. The extreme expressions used by the able and earnest Commissioner of Health had been better left unsaid, but due allowance must be made for any person who undertakes to conclude a case upon an *ex parte* presentation of it. It is not unusual under such circumstances for one to stray from the record, to offer one's own testimony as conclusive of the facts and to assume a complete knowledge of another's motives. Believing the Doctor to have misinterpreted his relations with us and our attitude toward him, I shall endeavor to explain our position to him and to your readers, always confining myself to the record.

The Doctor complains that the Pittsburg decrees have been misconstrued; that the issue "voluntarily raised" by the experts is based largely upon assumptions; that the experts made their reports without consultation with the State Health Department; that the department ought not to have been subjected to ridicule for matters over which it has no control; and that "the original intention with respect to spending the $40,000 city appropriation for investigations, as we understood it was, that most of this money would be needed for surveys and plans for the internal improvements . . . regardless of what the experts' findings might be as to disposal."

It may be that the city administration has taken the Commissioner's permits too seriously, but the sweeping character of the statute reinforced by pecuniary penalties that could readily be multiplied into a Standard Oil fine, plus the imperative form of the Commissioner's decrees give one the impression of an edict—a mandate not to be disobeyed or disregarded in the slightest particular.

The Commissioner's permits are four in number, containing 46, 21, 16 and 5 pages, respectively. For the sake of brevity I can quote only the opening paragraph and the material parts of the "conclusions" of the principal permit, viz.:

I, Samuel G. Dixon, Commissioner of Health of the Commonwealth of Pennsylvania, do hereby issue a permit to the City of Pitsburg, Allegheny Co., Penn., to make extensions of its sewerage systems in the Allegheny, Monongahela and Ohio River drainage basins of the city, in response to an application made therefor and bearing date of Jan. 19, 1909, subject to the following conditions and stipulations.

After a number of recitals and a statement of the problem the permit concludes as follows:

The State Department of Health is of the opinion that it will be found economical [!] to largely separate the storm water drainage from the sewage of local basins and main sewers and collect the flow therefrom at one point or a few main points where treatment of the sewage can be best applied and effected, keeping in mind the use of the Ohio River waters below Pittsburg and the ability of this river to receive without creating a nuisance an effluent free from disease germs.

Should the city of Pittsburg desire the assistance of the State Department of Health in bringing about coöperation between said city and the adjacent municipalities named hereinbefore and of others in the Greater Pittsburg district to which sewerage decrees have been issued or about to be issued, and will request such assistance, it will be gladly given.

CONCLUSIONS

. . . . . .

First. That on or before Dec. 1, 1911, the city shall prepare a comprehensive sewerage plan for the collection and disposal of all of the sewage of the municipality and submit the same to the Commissioner of Health for approval.

Second. On or before Dec. 1, 1911, the city shall have concluded such studies and tests as it may deem expedient to inaugurate and shall have decided upon a method for the treatment of its sewage and shall submit a report and plans thereof to the Commissioner of Health for approval.

. . . . . .

The State Department of Health will be glad to act in an advisory capacity to further the policy of bringing about the ultimate discontinuance of the discharge of untreated sewage into the waters of the state in the city of Pittsburg or its vicinity.

This permit before being operative shall be recorded in the office of the Recorder of Deeds for Allegheny County.

The permits were issued on Jan. 15, 1910, and spread upon the records of Allegheny County, Jan. 23, 1911. With due deference and apology for possible mistakes, I venture to resolve the Commissioner's grievance to formal propositions, viz.:

First. That the terms of the decree were misunderstood ("largely based upon assumption") or wilfully misconstrued by the officers and agents of the city so as to put the State Department of Health in a false light before the public.

Here, as elsewhere, the Commissioner's complaint is lacking in specifications, and the only answer that can be made is to suggest a comparison of the terms of the decree quoted above with a copy of the engineers' reports contained in ENGINEERING NEWS of Feb. 29, 1912. The city was directed to "prepare a comprehensive sewerage plan for the collection and disposal of all the sewage of the municipality." "The State Department of Health is of the opinion that it will be found economical to largely separate the storm-water drainage from the sewage of local basins and collect the flow therefrom at

one point or a few main points where treatment of the sewage can be best applied or effected . . ." This language is plain. It consists of direction and advice that I submit was obeyed and followed.

Second. That the expenditure of the appropriation of $40,000 for investigations was not properly apportioned as between the studies for collection and disposal.

Here again I hesitate to interpret the objection raised because of its vagueness. Is it that the inquiry was too thorough? Not only would common sense suggest an exhaustive study of both phases of a subject so closely inter-related that each is absolutely dependent upon the other, but the plain mandate of the Commissioner was to "prepare a *comprehensive* sewerage plan for the *collection* and *disposal* of all the sewage of the municipality . . ." Is it objected to that after the "studies and tests" were completed and the comprehensive plan prepared, an estimate of cost should have been made? Here again common sense is reinforced by the opinion of the State Department of Health "that it will be found economical to . . . collect the flow . . . at one point or a few main points where the treatment of the sewage can be best applied and effected." It should be of some interest to the State Department of Health to have its opinion verified, and a construction cost of $37,300,000, saying nothing of operation and maintenance, should have some weight in the deliberations preliminary to the adoption of a plan recommended.

Third. That a confidential and professional relation had been created between Dr. Dixon on one side and Mr. Hazen and me on the other, that had been "violated . . . through the concluding of the investigations and the publishing of the reports without consultations with the (State Health) Department."

This is the one clear criticism of the Commissioner's paper and can easily be answered. I apprehend in the first place that he does not wish to have it understood that no consultation whatever was had between Mr. Hazen and himself and his representative. Mr. Hazen at my request visited the Commissioner at his office in Harrisburg, before undertaking his employment in the early part of 1910 and then and there thoroughly discussed the Pittsburg sewerage situation. Since that time and throughout the whole period of his investigation, upward of a year and a half, Mr. Hazen and Mr. Sprague have had frequent interviews and consultations with Mr. Snow, the engineer and agent of the State Deartment of Health in all matters arising in relation to the sewage questions of this city.

I apprehend that the Commissioner's strictures relative to coöperation and consultation between him and us has reference only to the time of the completion of the Hazen report. It is to our actions at this point that he directs his wrath, and here lies the only real misunderstanding existing between us. If the Doctor had desired a copy of the report in advance of its publication and had asked for it, there would have been no hesitancy in furnishing it. He had notice last September that the studies were nearing completion, as appears from the following communication to him:

September 26, 1911.

Dr. Samuel G. Dixon,
Commissioner of Health,
Harrisburg, Penn.

Dear Sir:

Under an order of the State Department of Health the city of Pittsburg is required to make report with an estimate of cost in the question of sewage collection and disposal on or before Dec. 1, 1911. Nearly two years ago upon receipt of such order the firm of Hazen & Whipple, of New York, was retained by the city to study and report upon this matter. Their report is nearly complete, but they advise me that they should have the benefit of consultation with other experts in this field. The two months remaining before Dec. 1 will not be sufficient time for that purpose and, therefore, it is respectfully requested that an extension of three months from Dec. 1 be allowed. Mr. Hazen, who has been actively in charge of the investigation, assures me that a complete report can be made not later than Mar. 1, 1912.

Very respectfully yours,
(Signed) WILLIAM A. MAGEE,
Mayor.

In any event, regardless of whether the initiative rested with him or with us, what end would have been served by having the opinions of the engineers in his hands in advance of the city council? The engineers had literally followed his orders conveyed in official form, made their investigations along lines to reach the conclusions advised and directed by him and made report to the authority employing them in order that their principal, the city, might be advised in coming to a decision. The Commissioner's erroneous assumption that some personal and confidential relation existed in this matter is the root of all the trouble. There were no secrets—the whole thing was public. His permits were made a matter of public record a year after their delivery by the express directions contained therein and later insisted upon by letters from his department when some signs of neglect appeared.

The law provides and the formal decrees say the "City shall prepare . . . a plan . . ." and "the city shall . . . conclude studies and tests . . ." The city of Pittsburg does not determine its policies through, nor can it be bound by, the acts of its executive officers or agents. It can act in its corporate capacity only through its duly constituted corporate authorities, the council and mayor, and only by formal ordinance or resolution. The Doctor himself seems really to understand this. In the very midst of his fulmination he says, "However, up to this moment there is no issue between the city and the state." And again in the second paragraph of his letter to your journal: "The Pittsburg sewage problem cannot be properly discussed at the present because the deliberations of the city authorities have not been concluded so far as the department is informed. In good time the results and reports of the experts temporarily employed by the city will reach the state authorities." All of this is literally true and expresses correctly our position. I am sorry that Commissioner Dixon did not stop at this point and let it remain as the final expression of his position. There is no issue as yet between the State Department of Health and the city of Pittsburg; the deliberations of the city authorities are not concluded and the reports of the experts will be forwarded to the State Department at as early a day as the city council will direct.

A final word to explain the publication. There naturally could have been no inclination on our part to give undue publicity to such unwelcome news to the people of Pittsburg as a possible expenditure of $37,000,000. But there was no choice. In order that the "city" could "prepare . . . a plan . . ." and in order that the "city" should be able to conclude "such studies and tests . . ." the council had to be informed. There was but one manner of informing it., viz., by a message from the mayor. It is so provided by law and the statute also requires that the deliberations of the council shall be in the public view. The doors could not be closed and the decision reached in secret. Wise or unwise as this may seem from different viewpoints, public business must be transacted in public. When the mayor of this city conveys a message to council the matter becomes public. It is customary under these circumstances and highly necessary in order that the news may not be scattered in garbled form to prepare and furnish copies to the press and that was done in this case.

From first to last I and those associated with me have treated the subject in serious manner, have shown the utmost good faith and respect toward the State Department and its head, have observed every one of his precepts to the letter and are conscious of the fact that the matter is not closed.

WILLIAM A. MAGEE,
Mayor.

Pittsburg, Penn., Mar. 9, 1912.

Notes and Queries

Correction—In the article on the new Baltimore & Ohio R.R. tunnel in our issue of Feb. 22, the name of the tunnel was given incorrectly as Kingswood, when it should have read Kingwood.

A correspondent writes to inquire if there are any instances of expansion joints entirely separating the structural parts of a reinforced-concrete building. If any of our readers know of such a construction we would appreciate hearing of it.

Issued Weekly by

The Engineering News Publishing Company

JOHN A. HILL, Pres. CHARLES WHITING BAKER, Sec'y.
ALFRED E. KORNFELD, Vice-Pres. W.W. MAYER, Treas.
GEORGE H. FROST, Chairman Board of Directors.

505 Pearl St., New York.
1138 Monadnock Block, Chicago.
Home Life Building, Washington, D. C.
Z. P. Maruya & Co., Ltd., Tokyo, Japan.

CHARLES WHITING BAKER, M. N. BAKER,
E. E. R. TRATMAN, F. E. SCHMITT,
Editors.

Subscriptions payable in advance, $5.00 a year for 52 numbers, including postage in the United States, Mexico, Cuba, Porto Rico, Hawaii, or the Philippines, $7.00 in Canada.

To foreign countries, including postage, $9.00 or its equivalent, 36 shillings: 36 marks: or 45 francs.

Notice to discontinue should be written to the New York Office in every instance.

Advertising copy should reach New York Office by Thursday of week before date of issue.

Entered at New York Postoffice as mail matter of the second class.

CIRCULATION STATEMENT

During 1911 we printed a total of 931,958 copies.

Of this issue, 19,000.

None sent free regularly, no returns from news companies, no back numbers kept beyond current year.

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Engineering News

How far may a patentee control the use of his invention? In a decision on Mar. 11, the U. S. Supreme Court ruled, by a vote of 4 to 3, that he may make such restrictions as he pleases. The dissenting opinions, however, have found general support in the public press, and popular sentiment is unquestionably opposed to this decision. In suits now pending it is claimed that the bath-tub trust is held together by a patent on a process of enameling metal and that the shoe-machinery trust controls the shoe-making business on the strength of its patents on shoe machinery. There is no jealousy of the rewards reaped by a successful inventor as a result of the commercial use of his invention, but it is a misuse of the patent law when the power it gives to bring suit for infringement is made use of by a trust to stamp out competition.

It is to be hoped that this misuse of the patent system may lend strength to the present movement to inaugurate sweeping reforms in present methods of patent procedure and patent litigation.

The Pittsburg Sewage Disposal Order

Our "Plea for Common-Sense in State Control of Sewage Disposal," in connection with our abstract of the reports of Hazen & Whipple, Stearns and Eddy, and Sprague (ENG. NEWS, Feb. 29, 1912) on the Pittsburg sewage-purification order, has brought out a letter from Dr. Samuel G. Dixon, Commissioner of Health of Pennsylvania, and a reply thereto by Mr. Wm. A. Magee, Mayor of Pittsburg (pp. 548-552 of this issue).

Aside from questions as to the official relations between city and state authorities, ably discussed in the two letters, both the correspondence and the reports and the state order back of the reports raise highly interesting questions regarding the sanitary and economic phases of sewage collection and purification and state control of both.

For the convenience of any of our readers who may not have our issue of Feb. 29 at hand, it may be said that the gist of the Pittsburg case is that the state department of health virtually ordered Pittsburg to submit plans for separating its sewage and the sewage of adjacent districts from storm water and for purifying the sewage to a drinking-water standard, all for the assumed resulting protection that would be afforded to the water supplies of a few thousand people on the Ohio River below Pittsburg, which supplies do not come directly from the river and which, in so far as they are taken from the river or are liable to contamination from the river water, should be purified in any event. The able engineers employed by the city hold that the first installment of the necessary separation and purification works would cost over $37,000,000; that there is no need for material changes in sewage collection and disposal at Pittsburg, and that in so far as downstream water supplies are concerned it would be far cheaper to provide entirely new supplies than to separate and purify the sewage of the Pittsburg district.

The fundamental questions of country-wide interest involved in the Pittsburg case are: (1) the length to which the department of health of any state can wisely go in demanding sewage purification throughout a state, and particularly in trying to compel every city to prepare plans for sewage purification; (2) the extent to which a state department of health should dictate the character of local sewerage systems and sewage-purification works; (3) whether such a department is justified in making radical demands on a municipality without first conducting such a local investigation as will enable it to stand a fair show of proving the reasonableness of its demands to the satisfaction of the engineering profession and the courts.

It is not enough to say that a state legislature has authorized a state department of health to act according to its best judgment; that no such action is taken without the joint approval of the governor and the attorney-general; that numerous other orders have not led to resistance before the courts; or even that after legal resistance the state officers have been upheld. Such things may indicate legal authority, or perhaps mere non-resistance. They do not prove sanitary or economic wisdom, without which serious difficulty, if not disaster, is sure to follow in the course of time.

Finally, even if such radical action as has been taken in the Pittsburg case were tolerated or warranted in Pennsylvania, it does not follow that it would be at all wise in other states, which aroused themselves to the demands of modern sanitation earlier than did Pennsylvania; and particularly where local self-government is held in high regard and has not been found inconsistent with the real demands of public health and social amenity.

Lessons of an International Coal Strike

Four million workmen idle in Great Britain; two hundred thousand miners on strike in the Rhenish-Westphalia coal district of Germany; a deadlock between

the Pennsylvania anthracite-coal miners and mine operators, which promises a stoppage of all anthracite-coal production on Apr. 1; strong likelihood of another deadlock between bituminous miners and operators in the most important producing sections of the United States—that is the situation in the world's coal-producing industry at the opening of the third week in March, 1912.

Every intelligent person knows that the world's commerce and industry depend on coal, and knows that paralysis of commerce and industry means not merely discomfort, annoyance, loss of earnings and profits and dividends; but means that if the paralysis continues, a large proportion of the population of all civilized countries must perish from hunger. But it is one thing to know these things in the abstract. It is quite another thing to have them demonstrated by actual bitter experience. The world is learning its lessons in the fundamental principles of economics and sociology; not from printed books, but in the hard school of experience.

And one of these lessons which is being brought most forcibly home to millions of people is that they have rights in this labor dispute as well as the owners of mines and the diggers of coal. There is no law and no constitution higher than the law of self-preservation. "Necessity knows no law," the old maxim runs. The property rights of the coal-mine owner or the coal-mine operator, and the right of the coal diggers to conspire together to say not alone on what wages they will dig coal, but on what wages anybody shall dig coal—these rights are far inferior to the rights of the whole world to have coal dug and carried to market. For unless this life blood of our civilization is attainable, not only will the fires go out on every hearth and in every kitchen, not only will furnaces grow cold and factories stop, but railway trains must cease running and ships will no longer sail the seas.

The first lesson of the coal strike, then, is that government, which represents the whole people, cannot sit idle and allow capital and labor to remain at a deadlock to see which can tire the other out. It cannot do so for one thing because such a deadlock long enough continued would inevitably destroy government itself.

It is at such times of crisis as this that the advantage of England's unwritten constitution appears. Parliament, the supreme authority, is expected this week to enact a minimum wage law applicable to the coal-mining industry and to follow that up with whatever legislation may be necessary to relieve the crisis which is even now bringing famine close to many English homes.

It is much to be feared that when a similar crisis confronts this country, we, with our less elastic system of government with its system of checks and balances between the executive, legislative and judicial, may find it much more difficult to take the radical steps necessary to preserve peace and save the nation from anarchy and worse. The division of authority between national and state governments, advantageous as it is in many ways, has its disadvantages in times of crisis. At present the anthracite-mine operators and the miners' leaders have drifted into a deadlock, apparently for lack of some strong leader to strive to harmonize differences and prevent a strike.

It is easier by far to prevent a strike than it is to end one. It reveals a grave lack in our governmental system that there is no one to come forward and impress on operators and miners alike that the public interest in coal production is the biggest interest of all and that neither the operators or the miners can be permitted to take away the public's right to be supplied with a necessity of life.

Shall the American Society of Civil Engineers Have an Employment Bureau?

We referred in our last week's issue to the recent action of the Institution of Civil Engineers of Great Britain in creating an Appointments Board. At the annual meeting of the American Society of Civil Engineers, in January, a resolution was offered authorizing the President of the Society to appoint a committee of eight members, of which four were to be employing engineers and four engineers holding subordinate positions. This committee was to investigate "the conditions of employment of civil engineers throughout the country" and its report was required

> to set forth recommendations for action by the Society looking toward improving existing conditions and to include a report on the feasibility of this Society operating an employment bureau for its members covering all classes of engineering work.

When this resolution was offered at the annual meeting, a motion was made that it be laid on the table; but the motion was voted down. The official report of the annual meeting then continues as follows:

> Mr. Whinery—It is a departure from the method prescribed by the Constitution. The method prescribed by the Constitution for dealing with this question is that a motion shall be made to refer it to the Board of Direction. I move that the resolution be referred to the Board of Direction.
>
> The motion was carried.

It seemed to us passing strange that the Constitution of the American Society of Civil Engineers was so rigid a document that the members of the Society at the annual business meeting—the only meeting at which any considerable number of members are ever brought together—could not take any action on such a resolution other than to refer it to the Board of Direction.

We have been at pains to consult the constitution, and the only clause we find bearing on this point is the following:

> 12. Special committees to report upon engineering subjects shall be authorized, except as further provided in this paragraph, by a majority of the votes cast by the Society, and in the following manner: A proposition to appoint such a Committee shall be presented at a regular meeting of the Society, and if sustained, on a motion to refer the same to the Board of Direction, by an affirmative vote of not less than 25 Corporate Members, it shall be so referred.
>
> The Board of Direction shall then consider the same and report its recommendations to the Society at the next general business meeting, together with a statement of the arguments for and against the appointment of such Committee.
>
> If a motion for the issue of a letter-ballot thereon receive the affirmative vote of two-thirds of the Corporate Members present, the Board of Direction shall, within 30 days thereafter, issue the letter-ballot, accompanied by a statement of the arguments for and against the proposition.
>
> A majority of a total vote of not less than one-third of the Corporate Membership of the Society shall be necessary for its adoption, whereupon the Committee so authorized shall be appointed by the Board of Direction.

Now is the investigation of conditions of employment in the profession an "engineering subject"? Perhaps it is; but it is certainly *not* the sort of engineering subject which was intended to be covered by those who framed this clause of the constitution. This was intended to safeguard the Society against undertaking investigations of *technical* matters which were not of sufficient importance or sufficient general interest to a large proportion of the membership to call for such action.

However, let us assume that Mr. Whinery was correct; then what happens? According to the constitution above quoted, the Board of Direction *must* "report its recommendations to the Society at the next general business meeting," that is at the Annual Convention next summer. It cannot merely pigeon-hole the whole matter, and we trust it has no disposition so to do.

In our opinion the matter covered by the above resolution is by far the most important now before the Society. It ought to have been given full and frank discussion at the annual meeting. In the present situation the responsibility is placed upon the Board of Direction to take such action as shall best advance the interests of the profession.

The Society has properly taken ground in opposition to the scheme of having the state brand all engineers as competent who have passed a certain examination. It ought, therefore, to meet the proper demand of the public which desires to

know where it can obtain an engineer of assured competency for a particular piece of work.

A Quarter-Century of Attempts to Utilize Electricity in Sewage and Water Purification

The use of electricity for sewage and for water purification has been attempted again and again during the past twenty-five years. Some of the attempts have been based on but little knowledge of things electrical and few, if any, of them have shown a real conception of the sewage-disposal problem. Most of them have made far more use of the devices of the promoter than of the conscientious search for truth and progress which characterizes the scientist.

A brief review of some of the most notable of the so called electrical schemes of water and sewage purification, with a brief statement of some of the principles governing the possible use of electricity for the purposes indicated, is given below and a more detailed review, with references to fuller sources of information appears elsewhere in this issue. These reviews seem called for in view of the space given which we also give in this issue to a plant installed in 1911 at Oklahoma City, Okla., for the treatment of the sewage of that city. The discussion is all the more necessary because the Oklahoma City plant is an improvement upon one installed a little earlier at Santa Monica, Calif. The original Santa Monica plant, like a number of earlier experimental plants of the promoter originally responsible for it, was so overloaded with crude pseudo-scientific promoting humbuggery as to be ridiculous to the well-informed but utterly misleading to unsuspicious members of the general public—and apparently to some engineers who ought to have known better.

We may state in passing that although we have for some time felt that the promoting vagaries of the antetype of the Oklahoma City plant ought to be set forth, yet we disliked to give it even the publicity of exposure. While the Oklahoma City plant appears to have been contracted for, built and accepted by the city with great disregard of sanitary engineering and municipal business principles, yet there seems to have been sufficient good intention on the part of all concerned to warrant a description of the plant on its merits. This seems particularly desirable because efforts have been and are being made to introduce this or other so called electrical systems of sewage treatment in various parts of the country. Engineers and the municipal public should therefore be informed regarding the Oklahoma plant, its antecedents, and the general status of the so called electrical treatment of water and sewage. These remarks should not be interpreted as a condemnation of the Oklahoma City plant; but they are designed to aid in putting on their guard those who are more interested in the sound progress of sewage and water purification than in any particular method of treatment.

Before going further it should be stated for the benefit of those who have not had occasion to consider the subject that there has not yet been devised and does not seem likely to be devised any method for the direct electrical destruction or removal of the impurities of water or sewage. All that can be done with electricity is to produce some reagent for use in water or sewage purification. Any such reagent, with the exception of ozone and ultra-violet radiations, can be produced with equal, if not greater, economic and sanitary efficiency by some other means than electricity and at some point remote from the purification works where they are to be used.

With the exception of ozone and ultra-violet radiation, which are not ordinarily classed as electrical systems of purification, the electrical phenomenon utilized in the so called electrical water- and sewage-purification processes is electrolysis. This process is employed to produce either an oxidizing agent to reduce organic matter, a germicide to kill bacteria, or a coagulant or precipitant to assist in clarification by sedimentation or filtration. The electrolytic agent may be produced independently of the liquid to be treated, but in close proximity for immediate introduction; or it may be produced by electrodes immersed in the liquid under treatment. William Webster described both methods at least as early as 1889 and used the latter temporarily on London sewage. Hermite and Woolf employed the first method nearly twenty years ago, and others have tried similar but modified processes since. Harris, at Santa Monica, in 1908, and in his several earlier but merely experimental attempts, used electrodes immersed in the liquid under treatment, as is being done at Oklahoma City. All four of these men, it appears, merely produced one form or another of hypochlorite by electrolysis. No proof has been produced to show that these or some other hypochlorites could not be bought at least as cheaply in the open market.

This viewpoint exposes the whole subject of electrical treatment, real or so called, from a new aspect—or one quite different from that of even some of the most frank and disingenuous promoters. From this viewpoint and expressed in its simplest terms the real question at issue is: can a reagent of given efficiency be produced as or more cheaply by some electrical method carried out at a municipal plant built and operated for sanitary purposes or by some process, whether electrical or other, conducted by a commercial company in competition in an open market, and perhaps making and selling the reagent as a mere byproduct. This view takes away some of the mysterious popular glamor associated with electricity, but it certainly lets in a flood of light in its place.

It is a noteworthy fact that even the large cities which have used a hypochlorite for water disinfection have bought the commercial product rather than attempt to produce it themselves by electrolysis. It is perhaps even more noteworthy that in water purification, where the organic matter to be encountered is small, the use of hypochlorite is limited to bacterial reduction; and that when hypochlorite has been seriously proposed for sewage purification it has generally been considered advisable to remove the organic matter from the sewage before applying the hypochlorite.

The significance of the facts just stated is that hypochlorites, however produced, do not seem to be able to compete with other agents in the oxidation of organic matter, and that since their chief utility is as a germicide, and since organic matter has a great affinity for hypochlorites, they should be used only as a finishing process after the bulk of the organic impurities has been removed by other means. This principle is well established as regards the treatment of water by ozone, and even at that ozone is not on a commercially competitive basis with other means of reducing bacteria.

The long and short of the whole matter is that in the disinfection of sewage or water by any agent yet considered available, whether the agent be produced at the sewage works or elsewhere, by electricity or some other means, both theory and practice indicate the advisability of removing or reducing the organic matter before the application of the disinfecting agent, since otherwise a large percentage of the agent will be consumed in oxidizing organic matter. Furthermore, it is yet to be proved that electricity can be used at either water or sewage purification works for the production of ozone or of hypochlorites without greater expense and greater uncertainty as to sanitary efficiency than would be entailed in the use of other and more common means. The chief contingency in favor of ozone or hypochlorites produced by electricity, would be extremely cheap electric power, perhaps combined with high freight rates on commercial hypochlorites. The same general rule applies with even more force, judging from the Louisville experiments, mentioned in our general article, as regards the electrolytic production of coagulants for use in water purification.

From the foregoing comment, combined with the historical review given elsewhere in this issue, we think it will be evident that much remains to be done before any electrolytic scheme of sewage

treatment can be admitted into the family of approved processes or elements of processes of sewage purification.

We should feel that we had not done our duty if we failed to point out the inadequacy of the Oklahoma City contract to protect the interests of the city, the almost worthless character of such mere apologies for acceptance tests as were made, the failure of the contract to state who was to make the tests, and the wholly inconclusive if not absolutely damning character of such test data as appears to have satisfied the local authorities. All these things will be apparent to any engineer or ordinarily well informed business man who reads the excerpts from the contract, and the reports of the city and state bacteriologists and of the local commissioner of public works, as given in Mr. Hinckley's article.*

The guarantee clauses of the contract, aside from provisions as to daily capacity and yearly cost for electric current, consist of sweeping provisions as to character of the effluent. This must be "practically neutral and free from odor after the gases liberated by the treatment have had time to escape"(!); must be "free from disease germs" and "may be discharged into the creek without giving offense or endangering the health of the public"; and must "not undergo secondary decomposition under any climatic conditions."

Aside from an assertion that the effluent is free from odor, the report of neither bacteriologist contains a statement that the contract requirements as to sanitary efficiency were met. The bacterial results reported by the city bacteriologist cannot readily be understood, if at all. Those of the state bacteriologist appear to show non-fulfillment of contract. Neither set of analyses follow the lines almost universally employed by those who are accustomed to make sewage analyses or are familiar with the literature of the subject and the common limitations of sewage purification.

The report of the commissioner of public works adds nothing to the positive data on the sanitary efficiency of the plant. The rate of treatment is based on a measurement and "estimate" of the volume of sewage passing the works, made by the "cashier of the water department." The cost of current is based on bills actually paid, reduced to a per diem basis, but with nothing to show the actual average daily quantity of sewage treated during the six months the plant was supposed to be under test. Nor is there anything to show that the bills rendered by the water department covered the cost of the current to that department.

It is particularly interesting to note that while the nearest and only approach to a unit cost guarantee was the total annual cost for electric current, Mr. Hinckley's figures show that current cost is only 35% of the unit cost, or $2.59 against $9.17 per 1,000,000 gal. The actual yearly burden of the plant on the city is raised from the $9.17 already given to $12.87 per 1,000,000 gal. by a state law requiring the payment of $1000 per year into a sinking fund. This requirement may perhaps excuse the low depreciation rate allowed by Mr. Hinckley. However the unit cost figures are viewed, they show how little significance could be rightly attached to an operating cost guarantee which embraced nothing but electric current.

It appears from Mr. Hinckley's article that a considerably larger plant of the same type as that just described is under construction at Oklahoma City. It is to be hoped that the contract requirements for the new plant are better drawn than were those for the first one. While this is a matter of the irrevocable past, the city authorities have it within their power to see that whatever sort of acceptance test the contract authorizes is carried out, instead of accepting a second plant on the strength of such inconclusive and largely meaningless reports as are reprinted elsewhere in this issue.

Notwithstanding the length of this discussion we have been unable to give, except by suggestion, more than a partial idea of the magnitude, and in some instances the absurdity, of the claims made for various so called electrical processes of water and sewage purification and the actual results obtained. Aside from the work of Webster, the forerunner, which was creditable in view of the arts of electricity and sewage and water purification as developed up to that time, and the tests at Louisville, which were conducted on a comprehensive and scientific basis, none of the projects or actual plants for the electrolytic treatment of sewage or water appear to have been in the hands of men thoroughly versed in the principles and practice of either electricity or of water and sewage purification. The Woolf plant at Brewsters was a very small one, installed for a special purpose, but under promoting and political rather than scientific auspices. Whether tests of its efficiency were made in later years we cannot say, but that the city would install a duplicate of it now we do not believe. The Woolf plant of Danbury was virtually abandoned by court order, after a battle between sewage experts, as not preventing the nuisances it was built to abate. So far as we know, little or nothing of practical value has yet come from the comparatively recent British oxychloride process, except to point the way to still more recent use of commercial hypochlorites in water purification and to stimulate trials of the use of the same agent in sewage purification—the indication in the latter case being in favor of treating a clarified effluent unless under exceptional circumstances.

The Harris magneto-electric experimental plant at Louisville was a "complete failure." The Brownell and Mark electrodes and other tests made independently at Louisville by Mr. Fuller were only less discouraging in their results.

The Harris magneto-electric system at Santa Monica had to be materially altered in important elements before it became at all practicable, and the magnets were finally abandoned as of no use, or of insufficient value, even for popular exploitation purposes. His equally ridiculous "Sparking drum" had been abandoned after the first Louisville tests. Finally, the modified Harris systems at both Santa Monica and Oklahoma City, while accepted by the respective city authorities, vouched for in general terms by various persons in official or unofficial positions, have never been subjected to tests which would show either their sanitary or economic efficiency The unit cost figures in Mr. Hinckley's article are in part estimates, and since the accompanying reports show little as to what the plant is really accomplishing and that little is clouded by the vagaries of the report, there is reason to believe that the net outcome at Oklahoma City is a large unit outlay for results which could be attained by some other method at less cost.

A quarter century of experimental and practical tests leave the so called electrical processes of water and sewage treatment little further advanced than at the beginning. Some of the self delusions of the past seem to have sprung from a misconception of the very nature of electricity—from the idea that it was a mysteriously potent fluid instead of a mere manifestation of energy. Both theory and experience are alike against the direct application of electrolysis to the purification of either sewage or water, particularly liquids of either sort which contain considerable quantities of organic matter. The idea of "electrocuting bacteria," moreover, is as idle as that of killing the fishes in the sea by passing either high- or low-tension current say from Boston to Philadelphia.

Finally, we are not blind to the fact that in the march of scientific progress some method of utilizing electricity in sewage and water purification may be devised which will be a valuable aid to other processes, or even supplant them under some conditions; but we wish to emphasize the fact that if real advance is to be made, the methods of the promoter must be abandoned for those of the electrical and the sanitary engineer, the chemist and the biologist, each versed in his science and familiar with the state of his art.

*The "proofs" of the efficiency of the Oklahoma City plant would not be complete without a reference to a certain cow named "Daisy." What purport to be bacterial counts of milk drawn from this cow before and after drinking from the stream which received the effluent from the plant have been circulated as evidence of the freedom of the effluent from harmful bacteria; the supposition apparently being that bacteria in the water would appear in the milk.

Annual Convention of the National Association of Cement Users

The eighth annual convention of the National Association of Cement Users was held in Kansas City, Mo., from March 11 to 16, 1912. This is the first time in the history of the Association that it has crossed the Mississippi River for its annual meeting and the experiment was looked forward to with interest. As was to be expected the attendance was not quite so large as hitherto but was nevertheless of very respectable proportions, especially toward the end of the meeting, when the cement show was opened in a near-by convention hall.

The convention comprised five morning sessions, one afternoon session and five night sessions in the six days, in addition to a most successful banquet on the only remaining open evening. Contrary to some of the previous conventions of the Association, however, no additional meetings were required by overflow so that, at any rate, four afternoons were left open for such business or pleasure as the members might wish. Although there was an extraordinarily long program most of the papers were presented, though some of the committee reports did not receive the desired attention, as explained below.

PRESIDENT'S ADDRESS—President Richard L. Humphrey's presidential address consisted of a lecture illustrating some recent developments in concrete construction in Europe, as observed by him in a recent visit. He particularly commended the European engineers in their development of the material and advised American engineers to profit by the example set there. He noted, however, that the prevailing low cost of labor in Europe made possible many manipulations of the material and architectural embellishment which would not be possible in this country.

BUSINESS SESSION—It was reported that there were at present 1092 members of the Association as compared to 1048 a year previous. The Executive Board decided not to recommend the proposed increase in annual dues from $5 to $10, but recommended that an additional effort be made to obtain new members so that the desirable, but expensive, work of carrying on the association and particularly of issuing its publications, be continued at its present high grade.

COMMITTEE REPORTS

One of the important duties of the committees of this Association, if not the most important duty, is the formulation of reports embodying the standard practice along the particular line that the committee represent. These reports are first presented to the Association as "Recommended Practice," and when that has apparently reached a stable stage, they are changed to "Standard Specifications," or "Standards," both of which steps have to be approved first by the convention assembled and then by a letter ballot of the members. Necessarily the greater part of the work in making these standards must be done by the committee itself, but it is highly desirable that the members be allowed an active voice in their preparation, which can only be had by participation either in person or by letter in the discussion on the floor of the convention. Such an active participation was not evident at this meeting, partly because of the lack of available time (on account of the presentation of papers, which also is a necessary function of the Association) and partly because the committee reports were not available to the members until they came upon the floor of the convention, when obviously it is too late to allow of any intelligent discussion. To avoid this difficulty in the future, it is proposed that all committee reports involving standards shall be in the hands of the membership at least 30 days before the annual meeting, which leaves ample time for anyone interested to prepare a discussion.

The committee reports presented were as follows:

MEASURING CONCRETE—This committee reported that the present generally accepted method of measuring all kinds of concrete for bids by the cost per cubic foot is fundamentally wrong, mainly because it includes in such cost the cost of forms, finish and reinforcement, which items may vary exceedingly for the same volume of two different pieces of work. It therefore recommended a new system for measurement, which provides that monolithic concrete should be divided into its component structural parts, each to be priced separately, that ornamental cast concrete should be measured the same as cut stone now is, viz., by its limiting cubical measure and that structural cast concrete should be measured in the same manner as structural steel now is, viz., by separate estimates for manufacture and for erection. The recommendation was accepted, with a few amendments, to be printed as information.

SPECIFICATIONS AND METHODS OF TESTS FOR CONCRETE MATERIALS—The first report of this committee is largely tentative, and confines itself entirely to a discussion of the tests for fine aggregate or sand. The report states decidedly that at present not enough attention is given to the tests of the sand making up the fine aggregate of concrete and insists that such tests are fully as important as those for cement, which are so generally required. It states that while granulometric analysis and purely visual or manual tests of sand are of some value in discarding poor sand, the only really effective tests is a strength test on a cement mortar made from the sand. It supplements this recommendation by some suggestive methods now in vogue in certain laboratories. The report was accepted as a progress report.

BUILDING BLOCKS AND CEMENT PRODUCTS—This committee submitted a "Standard Specification for Testing Concrete Architectural Stone, Builders Blocks and Brick," and "Recommended Practice for Plain Concrete Drain Tile" and for "Concrete Architectural Stone, Building Blocks and Brick." These were referred to letter ballot for approval.

TREATMENT OF CONCRETE SURFACES—The report of this committee made last year was most thorough and the only changes this year were a few verbal ones in the main portion of the report and a suggested series of methods for testing waterproofing agents. This latter section was referred to the Committee on Specifications and Methods of Tests for incorporation in its standards. The Proposed Specifications for Portland Cement Stucco, reported last year, was referred back to the committee with the recommendation that it confer with two other societies which have prepared similar specifications, viz.: The Associaiton of American Portland Cement Manufacturers and the Metal Lath Association, for a possible standardization of all the specifications.

ROADWAYS, SIDEWALKS AND FLOORS—This committee submitted revisions of the old specifications on "Portland Cement Sidewalks," "Concrete Road and Street Pavements," and "Portland Cement Curb and Gutter" and new specifications on "Plain Concrete Floors" and on "Reinforced-concrete Floors." They were all submitted to letter-ballot for approval, without discussion.

REINFORCED-CONCRETE AND BUILDING LAWS—At the convention of the association last year it was recommended that this committee endeavor in the ensuing year to carry on loading tests on completed buildings of reinforced concrete using the then new method of measuring elastic deformation of the various members, so that some more definite idea of the behavior of these structures under load might be gained. The committee managed to raise by special subscription a sum of money sufficient to carry on four such tests with the aid of the services of the testing force of the University of Illinois Experiment Station and several reinforced-concrete concerns. These four tests were reported in detail at the convention. They embraced two buildings of the beam and girder type, one of the flat-slab floor type and one model full-size panel of a two-way tile and concrete floor. The measurements were all under the direction of experienced men and were most carefully conducted, and it is felt that a great step forward has been made in relating the

actual behavior of reinforced concrete under load to its design. The report contains full data on the experiments together with the computed stresses occurring in the members under load and the designed stress for the same conditions. They are too lengthy to describe other than briefly, but it is to be noted that tension in concrete, which, of course, is not figured in design, plays an important part in strengthening a structure under elastic deformation. In those sections of a member where the tensile value of the concrete is exceeded the computed stresses are very close to the observed, whereas in the other sections the discordance is quite marked. A future issue of ENGINEERING NEWS will contain an abstract of the report.

INSURANCE—The report of this committee consisted in additional recommendations which were not read but approved for printing in the *Proceedings* of the Association.

NOMENCLATURE—This committee submitted as information a tentative set of definitions of terms used in the concrete industry, which is to be printed as information.

PAPERS

The program called for 55 papers besides the committee reports. It was impossible to present all of these but a very great number were brought before the meetings. A resumé of the more important ones appears below:

FLAT SLAB FLOORS—Practically all of one session was devoted to a discussion of the design of the flat-slab or girderless floor system which is now engaging the attention of so many concrete engineers. The discussion was started by a paper by Sanford E. Thompson entitled, "The Practical Design of Reinforced-Concrete Flat Slabs." This is an amplification of Mr. Thompson's well known theory as described in Taylor & Thompson's "Reinforced Concrete." It assumes the system to be a flat circular plate extending with no curvature under load for a certain circumferential distance out from the column and supporting along that circumferential line (approximating the irregular line of inflection) the rest of the plate as a simple beam. The design of this circular supporting plate is dependent upon the indeterminate moments existing in it, and for the solution of these moments Mr. Thompson has used as a basis Prof. H. T. Eddy's theory of flat plates, from which he has deduced (by a complicated mathematical process not given in the paper) a series of moment formulas to be applied to the critical parts of the plate. These moment formulas contain certain constants, depending upon the dimensions of the column and span, which constants have been plotted to curves and appear as such in the paper. For the design of the supported slab a moment value of $\frac{Wl}{12}$ is assumed as a safe ratio compared to the apparent value of $\frac{Wl}{31}$ obtained in the building tests on flat-slab floors reported in the last convention of this Association. A typical design is worked out by Mr. Thompson by the aid of the diagrams and tables that accompany the paper. He states that values so obtained agree closely with those observed in the aforementioned tests, though it was pointed out in the discussion that this agreement is only for the stresses near the column head and not for the middle of the slab.

A. E. Lindau (Chicago, Ill.) criticized the paper on the ground that the assumptions of moments and stress made by Prof. Eddy were very questionable. Observations which have been made on elastic flat slabs of rubber (see paper by F. J. Trelease below) show that the line of contraflexure is not a circle and that assuming it to be such introduces various errors in the design. Prof. A. N. Talbot (University of Illinois) stated that the behavior of concrete under compressions in two directions 90° apart in the same plane is different from one-direction compressive action, and until this had been thoroughly investigated the application of Poisson's ratio (which was used by Mr. Thompson in the mathematical derivation of the supporting plate moments) is doubtful. Limited tests made at the University of Illinois on cross-shaped concrete members under compression at the ends of both arms of the cross showed less deformation in the area common to both arms than in either arm. He was not prepared to state how far this would affect the design of flat slabs, but considered it a field for investigation.

F. J. Trelease (Chicago, Ill.) read a paper entitled, "The Design of Concrete Flat Slabs," which described in detail an involved series of tests recently carried on by the Corrugated Bar Co. to be used as a basis for establishing a flat-slab design. The fundamental knowledge needed to proceed to such a design relates to the behavior of an elastic flat slab supported by points and under a uniform load. If the appearance of such a slab could be determined and the inflection lines noted the action of the internal forces might be better understood. To this end, after considerable study of various materials, a small flat rubber plate about ½ in. thick and some 3 ft. square was placed on carefully spaced small square columns as the top of an air-tight box, which was exhausted of air by a pump, thus permitting the accurate measurement of the downward pressure on the surface as well as an observation of the convolutions of that surface under load. By the aid of a microscope and carefully placed indicator strips of brass fastened to the surface the progressive movement of all parts of the slab was observed and measured under load. From these observations deflection diagrams were drawn and, by the aid of other tests on the elastic properties of the material, moment diagrams plotted. As a part of the work, models were made showing the exact state of the deformations, so that the behavior of the slab might be apparent.

Using these studies as a basis a method of designing the slabs was worked out, in which the position of the lines of inflection is definitely determined and the moments thereby computed. The tests were extremely useful as showing the exact behavior of a homogeneous flat slab under load, even though the behavior of a non-homogeneous reinforced-concrete slab may not be precisely the same.

TESTING BUILDINGS UNDER LOAD—In line with the report of the Committee on Reinforced Concrete and Building Laws noted above, Prof. W. A. Slater (University of Illinois) delivered a paper entitled "The Testing of Reinforced-Concrete Buildings Under Load," which described the technique of such testing. In all, eight buildings have been so far tested under this system of precise measurement of material deformation and the degree of accuracy has been increasing with each new test. He emphasized the need for the greatest care in the measurements, which should be made by men experienced in this type of work. Even with such expert aids the number of readings must be large so that possibilities of errors be lessened. As regards loading material he stated that any heavy material may be used, though those that lend themselves to ease of removal and do not tend to arch are the best. Arching action, however, may be avoided by the division of the load into a number of smaller parts, which also allows room for the observation points. The load, while not over the whole system of panels under test, may be so arranged as not to cause moments and stresses very greatly different from those caused by a total uniform load. Finally he stated that all cracks, however minute, should be observed, as they are very valuable indicators of conditions of stress. The cost of these tests has varied from $50 to $2000, so there is not much basis for any estimates on future work.

FIELD TESTS FOR CONCRETE—F. von Emperger, of Vienna, Austria, sent a paper entitled "The Necessity of Field Tests for Concrete" which described in detail the field flexural test which he has devised and which was described in ENGINEERING NEWS, Dec. 21, 1911. This test consists in the molding and breaking under simple flexure on the job of a series of small simply reinforced beams so designed that the relation of the breaking load to the available crushing strength of the concrete is direct and mathematically simple. In using this method, concrete may be taken from the work as it is being laid and its strength tested at regular stated intervals, the results

being used both as a criterion of strength and of the time limit for form removal. In the discussion, Prof. A. N. Talbot said that while the necessity for some such test beam is very apparent, it seemed that Mr. von Emperger's beam was so small as to make its manufacture on work very difficult. He thought that a good deal of study would be required to design a beam which at the same time would be easy of manufacture and concordant in testing results. President Humphrey reported that in a recent visit to Europe he was not favorably impressed with the concordance of results on the von Emperger beams or with the reliability of the values gained from them.

G. H. Bayles, of the New York Dock Co., New York, presented a paper along similar lines to the one above, describing field tests on concrete cubes made along with actual construction on a warehouse in Brooklyn, N. Y. The results of these tests are given in a paper written by Mr. Bayles for ENGINEERING NEWS, and to appear soon.

Rudolph J. Wig (U. S. Bureau of Standards) described some tests made by the former government laboratory at St. Louis (now under the U. S. Bureau of Standards) in which three different contractors, under the direction of the laboratory experts, simultaneously and at the same location made test beams of similar design and composition, each according to his own field methods and with his own force, the only variables being in methods of mixing and the amount of water used, which latter, however, was carefully measured for purposes of record. The beams so made were then tested under load and compared with similar tests of laboratory-made beams. The percentage of variation ran all the way from 100 to 200% in almost every beam, two of the contractors' beam-series running far below the laboratory tests and those of one contractor, which latter two were about the same. It appears from the results that in time the strength of all the beams would have closely approximated one another, but for the early tests the variation was very marked, showing how greatly the method of mixing affects strength. The tests are soon to be published in a government bulletin with full details given.

CLACKAMAS RIVER DAM—H. V. Schreiber (Philadelphia, Penn.) described the construction of a hollow reinforced-concrete dam of the Ambursen type recently completed for the Portland (Ore.) Railway Light & Power Co. The dam itself presents no particular novelty except in the investigation of its foundations, which are on a lava-rock formation of decidely porous nature. The outward appearance of this rock was such that fears were entertained as to its safety as a dam footing, and extensive boring and grouting investigations were made previous to the design.

It was then decided that the work was sufficiently strong to bear safely a pressure of 100 lb. per sq.in., and a hollow reinforced-concrete dam was designed giving just about that unit pressure on the base. In order to ensure against percolation under the dam, however, it was decided to grout the porous rock under the line of the toe of the dam, thus forming there a solid cut-off wall. These grouting operations were carried on by boring two continuous lines of holes across the dam site, filling them with grout under 100 lb. pressure, and then boring a middle line of holes, which were put under the same water pressure as the dam was designed to withstand, meanwhile observing the leakage through these test holes. In completing the grouting operations it was found that no leakage occurred in the test holes, although the grout holes showed considerable leakage before the grouting operation. The power developed is about 25,000 hp. under 83-ft. head of water.

CONCRETE FOR GAS-HOLDER TANKS—In a paper entitled "The Suitability of Concrete for Gas Holder Tanks," Herbert W. Alrich (Consolidated Gas Co., N. Y.) opposed the use of anything but steel for such tanks. His opposition to concrete was on the ground of its greater cost, longer period for construction, liability to impairment from deteriorating external elements, difficulties of repairing, possibilities of corrosion, inaccessibility of metal, greater load on foundations, difficulty of inspection and supervision and increased labor for excavation. It was pointed out in the discussion that with the exception of the last point, these objections would hold in any type of construction where concrete is used in competition with steel, so that the objections were against concrete as a whole and not against it as a material for gas-holder construction.

LARGE REINFORCED-CONCRETE DOMES—Dr. S. J. Trauer (City Building Engineer, Breslau, Germany) sent a paper describing a monster reinforced-concrete convention hall, now being built at Breslau, the main feature of which is a hemispherical dome, composed of semi-circular reinforced-concrete ribs of 220-ft. span, which abut against a circular ring held up in turn by arches in the line of its circumference and by flying buttress half domes, in all a most complicated structure. A paper describing the "Design of the Reinforced-Concrete Dome of the St. Louis Cathedral," by Hugues Brussel (St. Louis, Mo.) was read also, but only by title.

CEMENT SEWER PIPE—A paper entitled "Advantages and Durability of Cement Sewer Pipe," by Gustave Kaufman (Brooklyn, N. Y.), described in some detail the construction and operation of a machine now in use making pipe under 24-in. diameter for use in the sewers of Brooklyn, where similar pipe to the extent of 400 miles has been laid in the past 40 years. These pipes have given good satisfaction, showing superiority in wear and first cost over any other type. The latter part of the paper was devoted to a refutation of the charge that sewage attacks the concrete of small pipe, based mainly on the good behavior of the Brooklyn sewers.

A paper by Prof. Duff A. Abrams (University of Illinois) entitled "Methods of Testing Cement Pipe," described a portable testing machine which has proved of good service in the laboratories of the University of Illinois. It consists primarily of a long lever arm, simply weighted at one end and hinged at the other, with a bearing block between. The pipe under test is placed between this block and a base plate and crushed by the increase of the weight on the extended arm.

CONCRETE FENCE POSTS—Two papers by railway engineers, Messrs. W. J. Towne (Chicago & Northwestern R.R.) and L. J. Hotchkiss (Chicago, Burlington & Quincy R.R.), described plants installed by railways for the manufacture of fence posts. As yet these plants have hardly reached a permanent basis, but the product turned out has been uniformly good and has cost just about the same, or perhaps a trifle more, than the ordinary cedar post heretofore used. Both companies have been well pleased with the work.

CONCRETE BRIDGES—W. S. Gearhart (State Highway Engineer, Kansas) delivered an illustrated lecture showing the bad and good bridges which have been built by towns and counties in the State of Kansas. The slides illustrating the lecture are ones used by Mr. Gearhart in his publicity work for the State Highway Department, in its efforts to persuade communities to build permanent strong bridges instead of the sometimes originally cheap but in the long run highly expensive bridges which the average lay highway body is apt to provide. He was particularly critical of the light steel bridges, so light "that one could scarcely take a picture of them" and the "tube" or steel cylinder piers so poorly founded and braced as to afford a fair victim to all excessive floods. He did not advise concrete bridges to the exclusion of all others but mainly insisted on some type of strong bridge built under competent engineering supervision. He did advocate, however, for the generally flat country of Kansas, the girder type of concrete bridge which has been so effectively developed by the State Highway Department of Illinois.

Following Mr. Gearhart, D. B. Luten (Indianapolis, Ind.) read a paper advocating the use of concrete arches instead

of the flat girder bridge of concrete. He claimed that the arch is the natural form in which to mold concrete, that it is less liable to failure from settlement than the girder and that it presents fully as effective a waterway under most conditions. W. H. Finley (Chicago & Northwestern Ry.) in a paper entitled, "Flat Slab Bridges," presented the advantages of this type for railway work.

HIGHWAYS—M. O. Eldridge (U. S. Office of Public Roads) delivered an illustrated lecture showing good types of highways in the ancient and modern world, some examples of deplorably bad roads in this country and some typical views in the progress of making macadam, sand-clay and bituminous surfaced highways. Preparatory to the lecture he presented some figures prepared by the U. S. Office of Public Roads to show the financial beenfit to be derived from road improvement. According to this estimate, if only 20% of the public roads in the United States were improved there would be an annual saving to the country of $250,000,000 per year, made up in increased value of land and saving in cost of haulage and in cost of harness and equipment. This is partly based on an estimated cost for haulage on a bad country road of 25c. per ton mile and of 12½c. per ton mile on a good road. He did not say how this saving is to be directly transmuted into funds for road construction and maintenance.

This was followed by a talk by County Judge H. C. Gilbert (Kansas City, Mo.) on "The Necessity of National Aid in Good Roads." This address first referred to the past action of the federal government in the construction of roads, a movement which was stopped by the growth of the railway, passed on to the obvious benefits to be derived from road construction and then presented some arguments in favor of national highway construction. Briefly these were that the government owes to the various communities a certain compensation for the uses of roads for postal purposes, that it has spent vast sums on other national enterprises such as rivers, harbors and public buildings, that it now improves the roads in the insular possessions, that it benefits the manufacturers by a protective tariff and therefore should benefit the farmer by highway construction. Judge Gilbert did not refer to the details of raising money for this construction or of the disbursement of it equally among the various states.

CONCRETE ROADWAYS—Two papers describing concrete roadways or street pavements were read, one by F. P. Wilson, city engineer of Mason City, Iowa, and the other by E. W. Groves, city engineer of Ann Arbor, Mich. In Mason City, about 70,000 sq.yd. of the pavement described has been put in at a cost of $115,000 and has been in service for various periods up to three years with good results. It is a two-course pavement, the bottom of 5 in., 1:2:5 stone concrete laid on a solid footing and the upper course, bonded to the bottom while the latter is still wet, a 2-in., 1:2 sand mortar. It is provided with asphalted expansion joints along the curbs and across the street at intervals of 25 ft. and in the newer streets of 37½ ft. Later improvements provide a steel guard plate at expansion joint.

The Ann Arbor pavement is a bituminous coated concrete roadway, formed by placing a thin coal-tar skim filled with sand upon a solid concrete base. Within the last three years 84,000 sq.yd. have been laid at an average cost of $1 per sq.yd. In construction there is a base course of 4½ in. 1:8 (run-of-bank gravel) concrete and a bonded 1½-in. of 1:2 (gravel bank) upper course. In the new construction a 6-in. 1:4½ one-course section is to be used. On this, when hardened, is spread a hot bitumen at the rate of ½ gal. per sq.yd. of road surface and this is then brushed smooth with an old sweeper. While still hot a thin coating of torpedo sand is spread over the surface and the whole surface compacted by the regular traffic, to which it is immediately opened. This tar coating approximates ¼-in. in thickness and is estimated to cost 7c. per sq.yd. It is thought it will need replacing in a comparatively short time, though three years has not yet shown it to be necessary.

OTHER PAPERS—A. O. Cunningham (Wabash R.R.) in a paper entitled "The Use of Reinforced Concrete on the Wabash R.R.," showed many views of the bridges, abutments and culverts of concrete in that road. The Wabash R.R. was the first in this country to adopt reinforced concrete for its structures, an abutment having been built in 1902. It is interesting to note that as a result of experience, its engineers have adopted a high-carbon deformed reinforcement, using 18,000 lb. per sq.in. as a safe tension value and a 1:2:4 concrete capable of standing 2400 lb. per sq.in. in 60 days, with a designing unit stress of 800 lb. per sq.in., both values somewhat higher than in current official specifications.

E. Lee Heidenreich (Kansas City, Mo.) described the growth of the use of reinforced-concrete grain elevators in this country since the first built in 1899. Particular interest is now being shown in small farmer's elevators of about 50,000 bushel capacity, which are being built in square sections instead of the circular tanks generally used for the larger elevators.

James L. Darnell (Kansas City, Mo.) showed a number of views of buildings recently erected by the unit system of construction, in which each member is cast on the ground, swung into place and fitted together in the structure by interlocking reinforcement and poured grouting. The development of the interlocking feature has been the leading factor in the growth of this system, as the joints unless thoroughly made are apt to prove weak places in the structure.

Other papers upon subjects heretofore described in ENGINEERING NEWS were "Cement for Protecting Steel Pipes along the New York Aqueduct," by Alfred D. Flinn (Board of Water Supply, N. Y.), and "Reinforced-Concrete Telegraph Poles, Pennsylvania, R.R.," by George Gibbs (Pennsylvania R.R.)

OFFICERS

The officers for the present year were reëlected for the coming year, with Richard L. Humphrey (Phila, Penn.), as President, and H. C. Turner (N. Y.) Treasurer. The Secretary is E. E. Krauss, Harrison Bldg., Philadelphia.

Schemes for "gravity" railways were extensively agitated in New York 20 years ago prior to the contsruction of the Rapid Transit underground lines and the tunnels under the East and North Rivers. These schemes are brought to mind by the news that a gravity tube railway system is now being exploited in London. The engineering supplement of the London "Times" of Feb. 21 devotes two columns to a description of the system, which is the invention of E. W. Chalmers-Kearney. Mr. Kearney follows previous inventors of gravity railways in placing his stations at summits with a steep grade on either side. The grade proposed is 1 in 7 or over 14 per cent. and between stations two miles apart the line would descend to a depth of 100 ft. It is estimated that by this means about five-sixths of the power required for accelerating the train, as well as the wear and tear due to the use of brakes for stopping at stations will be saved. Mr. Kearney also imitates numerous American inventors by adopting a single-rail system, the car being kept upright by a central overhead guide rail. The novel feature in his scheme is the proposal to use only a single track for trains running in both directions. There are automatic turnouts at stations, so that a train entering the station from either direction takes the turnout at the right. These turnouts are supposed to be interlocked so that a train cannot start from a station if the section between it and the next station is already occupied by a train. The inventor's confidence in the safety of his scheme is set forth as follows in the "Times" article:

In order that all question as to safety may be set at rest it should be pointed out that the mono-tube offers a greater degree of safety than the ordinary working of tube and surface railways, inasmuch as it is impossible for more than one train to occupy any given line at the same time and the possibility which exists on the present tubes of a rear-end collision is thereby removed. In addition the single-tube system ensures that a train will never be stopped between stations for signals, as before the train can move the line must be clear to the next stop.

That automatic blocking and interlocking can make a single-track road safer than a double-track road will be comforting news to a good many American railway managers.

The most surprising thing about the whole scheme is that its inventor has been able to raise money enough to build a full-sized car 45 ft. in length and 8 ft. in width to demonstrate his ideas.

The Alleged "Volcano" in Culebra Cut

Widely published newspaper dispatches reported last week the appearance of volcanic action in Culebra Cut, the escape of steam, blue smoke highly charged with sulphur, and gas hot enough to fire combustible materials. An official report on the occurrence is given in the *Canal Record* of Mar. 6. It appears that on Feb. 12, the Division Engineer of the Central Division reported on the phenomena as follows:

A little less than three weeks ago I noticed that the material at the locality described was sending up in the early morning quite a thick cloud of white steam or vapor. I examined the spot a day or two afterward and found that for a width of about 20 ft., length of about 100 ft. and a depth of about 15 ft., the entire mass of material recently blasted appeared to be heated to a considerable temperature. Steam was escaping from numerous small openings and from four principal vents, or openings; the smallest of the four being about three inches in diameter and the largest about one foot. The temperature was so high that the hand could not be held at the mouth of the larger openings for more than a second or two, and when withdrawn was quite moist, showing quite unmistakably the presence of steam or heated vapor. The sides of two of the vents were encrusted both with white and yellow powdered material, the yellow appearing to be sulphur. What the white powder was I am unable to state.

I have observed this locality almost daily for over two weeks, and within the past four or five days there has been quite a change in two important characteristics. The temperature has increased and a pale blue smoke, instead of steam, is now emerging from the vents. The odor of sulphuric acid, which was very marked when only steam was emerging, is fully as marked today. To give an idea of the temperature of the larger vent I took a nine-inch brown Manila envelope and held it at the mouth of the largest vent for three seconds, when it was totally destroyed, although it did not ignite in flame. I then took a piece of the white pine covering of a dynamite box and held it for three minutes within the mouth of the largest vent and on withdrawing it, it was completely charred, so that another three or four minutes' exposure would probably have carbonized it completely.

. . . . . .

I would respectfully recommend that the Commission Geologist be requested to make a careful examination and submit, as promptly as possible, a report on this matter, as it is one of great interest to the work and undoubtedly concerns the safety of our men who are handling dynamite. As you may recall, we have had premature explosions in the past on at least two occasions due to chemical heating of the rock, and I am convinced that the material which I have described was hot enough to have readily fired dynamite at any time within the past three weeks.

The following is extracted from the report of the Commission Geologist, D. F. MacDonald:

The marl shales, through which Culebra Cut extends, in the region opposite the Culebra railway station, have, from time to time, on exposure to the atmosphere, become hot. The intensity of this heat has varied from noticeably warm to a temperature sufficient to readily char wood, without, however, causing it to burst into a flame. The duration of this heating has been from a few days to several weeks. These shales are dark, thin-bedded, soft, and easily crumbled, and some of the layers are largely fine basic tuff, or volcanic ash, loosely cemented by lime. Other beds contain more carbonaceous material, with some local partings of lignite, an inch to a foot or more thick.

After exposure to the atmosphere by drilling, or blasting, certain local areas of this formation become, in the course of a few days, warmed up, and as the heating goes on the carbonaceous matter in the shales is gradually oxidized off and they tend to assume a gray to dull reddish color.

The most aggravated case of heating so far noted is now going on in Culebra Cut, about 350 yd. north of the foot of the stairs at the observation tower near Culebra Station. The mass of heated ground here is about 500 ft. long by 20 ft. wide, and the action reaches a depth of perhaps 15 or 20 ft. Blue smoke, which contains a high percentage of sulphur dioxide, issues from vents in the mass, and fragments of wood inserted in these are readily charred and consumed. A small amount of steam may also be detected emanating from local moist spots, but this is mainly due to the vaporization of ground water. In the investigation of this heated mass samples were taken, and these were tested qualitatively for sulphuric acid and for sulphates of calcium, aluminum and magnesium. The tests revealed the presence of all of the above substances, both in the shale and as the white coating on the moist spots and steam vents of the mass. The yellow deposit near the larger vents is sulphur. Sulphuric acid, especially, was shown to be present in considerable quantity.

The origin of the sulphuric acid here was at first a puzzle, because the examination of many samples, with the naked eye and with the microscope, failed to reveal the presence of pyrite. Finally samples of 8 to 10 lb. were taken, ground with water in a large mortar for some minutes, and then concentrated to a few ounces by washing or "panning." This concentrate showed a high content of pyrite, much of which could scarcely be seen with the naked eye. Under the microscope very small crystals of pyrite were noted; also considerable magnetite, present as black sand, and some subangular to fairly rounded grains of quartz.

The mainspring of the action here, then, as in the other instances observed, has undoubtedly been the oxidation of the pyrite. The reasons why this oxidation has been so rapid and effective, seem to be as follows:

(*a*) The finely divided, almost microscopic, character of the pyrite gives maximum surface exposure to atmospheric agencies and greatly promotes oxidation.

(*b*) The very warm, moist atmosphere. The tropical sun shining directly on dark rock surfaces produces a temperature sufficiently high to greatly promote oxidation, especially in the presence of slight moisture.

(*c*) Once oxidation of the pyrite has been started the heat thus generated tends to accelerate chemical action and thus the heating increases in geometric progression.

(*d*) When the heat of pyrite oxidation reaches the comparatively low temperature of oxidation of the hydrocarbons present in the lignitic shale, they, too, become oxidized and still further add to the temperature. Finally the fixed carbon content tends to become oxidized, at least in part, and gives maximum intensity to the action.

(*e*) Some heat is also generated by the action of the free sulphuric acid on the calcium carbonate for the formation of gypsum. Other minor chemical actions added their quota to the total heat.

As the temperature rises all chemical activity is vastly stimulated and the heating increases to a maximum. After the most readily oxidizable substances are consumed the heat gradually dies down toward normal temperatures, which may be reached in a few weeks or months. The intensity and duration of the heat depend largely upon the percentage of finely divided pyrite, volatile matter, and fixed carbon in the rocks.

In order to alleviate the danger of premature explosion from loading dynamite in holes which have become hot, Colonel Gaillard has inaugurated the practice of testing holes in the vicinity of the heating areas, by dropping into them a small iron pipe longer than the hole. This is withdrawn at the end of ten minutes and quickly passed through the hand. In this way not only is heating detected but the location of the heated zone with respect to the depth of the hole is also made known; for the heating is at times only local and may be at, or well above, the bottom of the hole.

Oil Engines Are to Be Used for a fleet of 14 vessels now being built for the Glasgow (Scotland) Motor Coasting Co. Eight of these vessels, of 140 tons each, will have 90-hp. engines and are intended for traffic on the Forth and Clyde Canal. Two others are to be of 230 tons with 120-hp. engines, two more of 280 tons with 130-hp. engines, and two of 360 tons with 160-hp. engines. The fuel tanks of all these vessels will hold oil sufficient for three weeks' running. The 140-ton vessels can carry 35 to 40 tons more cargo than similar vessels propelled by steam.

A Pump Delivering 50 Gal. Per Min. at a Pressure of 5000 Lb. Per Sq. In.

For use in connection with hydraulic forging presses, drawing benches, cartridge-case presses, etc., pumps are not infrequently made which supply water at pressures of from 3000 to 6000 lb. per sq.in. The capacity of such pumps rarely exceeds 10 or 15 gal. per min. Two pumps, however, were recently built which are designed for a pressure of 5000 lb per sq.in. with a capacity of 50 gal. per min.

These pumps, one of which is shown in the accompanying illustration, are of the horizontal duplex type with outside-end-packed plungers. Each pump has four 2⅛-in. diameter plungers, with a common stroke of 18 in. This gives the desired capacity of 50 gal. per min. at 47 r.p.m.

Each cylinder, with its valve chamber, is made complete in one piece from a steel billet. The cylinder bores and all internal water passages subject to the discharge pressure are drilled from the solid. The valve service is of tool steel with the faces of the valves and seats hardened. Each valve is separately accessible from above through its individual hand-hole opening, to facilitate the refacing of valves and seats. The plungers themselves are of tool steel ground round and parallel within very close limits throughout their length to minimize the wear on the packing. The plunger packing is of the multiple-leather-cup type, as shown in Fig. 2.

The plungers being of small diameter, the stroke relatively long and the net plunger load high, especial precautions were taken to prevent plunger deflection. The weight of the plungers, crossheads and side-rods is supported at both ends of the cylinder on adjustable shoes. In addition the alignment of the side-rod is maintained by guides on the yoke and on the outer end of the cylinders. The permanence of alignment of the complete unit is sought by the provision of a deep heavily ribbed gray-iron base extending from the base frame entirely under the yoke and water cylinder.

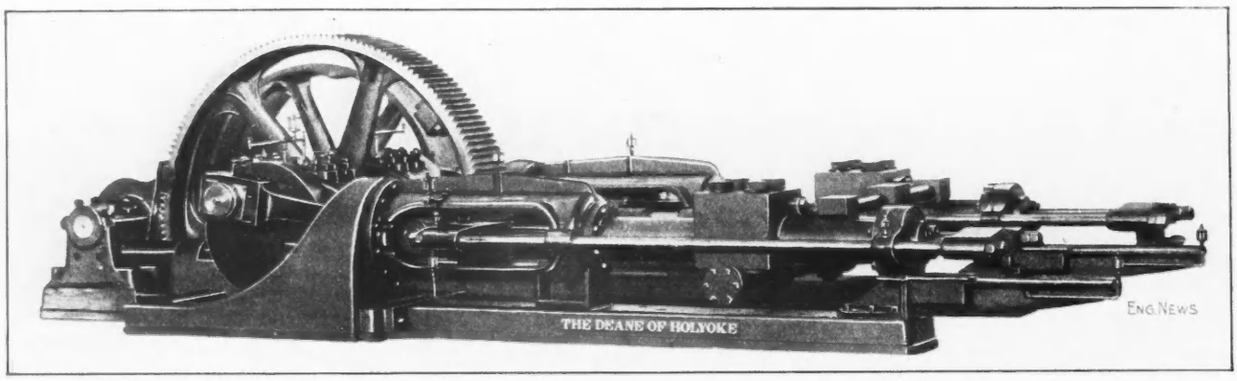


FIG. 1. DEANE HIGH-PRESSURE PUMP OF UNUSUALLY LARGE CAPACITY
(50 gal. per min. at 5000 lb. per sq.in.)

These pumps were made by the Deane Steam Pump Co., of Holyoke, Mass., to which we are indebted for the information for this article. We are informed that the two pumps were delivered within five weeks after the receipt of the order.

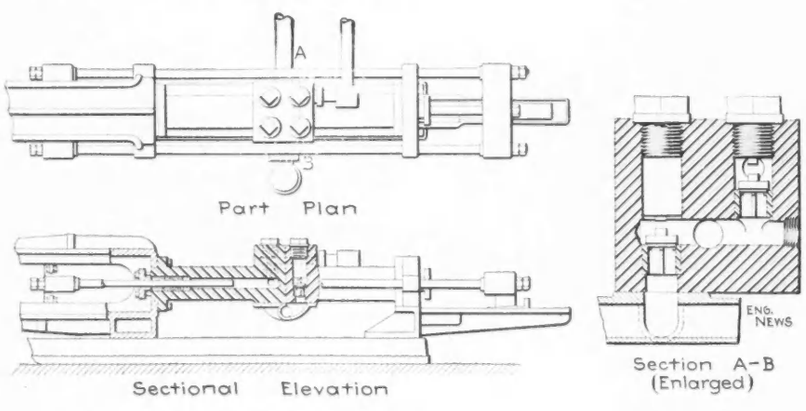


FIG. 2. PLAN VIEW OF HIGH-PRESSURE PUMP WITH SECTIONS THROUGH CYLINDER AND VALVE CHAMBER

Annual Convention of the American Boiler Manufacturers' Association

The twenty-fourth annual convention of the American Boiler Manufacturers' Association was held at New Orleans, Mar. 12, 13 and 14. Conjointly there was a meeting of the American Boiler Supply Men's Association. There were in all about 150 members and guests present.

At the opening session there was the usual exchange of felicitations between the mayor of the city and the officers of the societies. The second session afforded an opportunity for a discussion of the proposed congressional plan of removing the tariff from sugar. The boiler makers felt drawn into the matter since there was 1,200,000 hp. of boilers in use by the Louisiana sugar men. A resolution was passed asking congressmen and senators to vote against such proposals. At a later session resolutions were also adopted condemning the trend of legislation against railroad corporations.

On the second day, a convention-place committee reported in favor of holding the next meeting in Cleveland, and their proposal was accepted. It was announced that the 1913 meeting will be a silver-anniversary celebration. At this session the old officers were all reëlected: President, E. D. Meier of New York City; Vice-Presidents, T. M. Rees of Pittsburg, J. D. Smith of Charleston, S. C., W. A. Brunner of Phillipsburg, N. J., H. D. MacKinnon of Bay City, Mich., M. H. Broderick of Muncie, Ind.; Secretary, J. D. Farasey of Cleveland; Treasurer, J. F. Wangler of St. Louis.

The supply men elected as President, J. T. Corbett of J. T. Ryerson & Son, Chicago; as Vice-President, Thomas Aldcorn of the Chicago Pneumatic Tool Co., New York City; as Treasurer, H. B. Hare of the Otis Steel Co., Cleveland; as Secretary, F. B. Slocum of the Continental Iron Works, Brooklyn, N. Y.

There was a banquet on the night of Mar. 14 for both gentlemen and ladies in attendance, and a full program of entertainment was arranged for the latter during the whole convention period.

PAPERS—In the paper, "Steel Rivets," D. J. Champion, of Cleveland, pointed out the improvement that had been secured in rivets by the use of soft basic openhearth steel, in spite of misuse like cold hammering. He was adverse to the "nicking and bending" test for steel rivets, claiming that it showed the presence of normal fibrous structure in iron, but had no such value for steel.

This paper was followed by one from H. J. Hartley, of the Cramp Ship Building Co., of Philadelphia, in which he related in detail his experiences with hydraulic riveting machinery.

George Thomas, 3d, of the Parkesburg Iron Co., presented a paper, "History of Charcoal Iron and the Manufacture of Charcoal-Iron Boiler Tubes." This was partly descriptive and partly given to a recital of the claims for puddled iron in preference to soft steel. He stated that in 1910, 73,974 gross tons of blooms were made—enough to equip 10,000 locomotives with boiler tubes after allowing for manufacturing waste.

This was followed with a paper by J. J. Dunn, of the Shelby Tube Co., Ellwood City, Penn., describing the development of present processes for rolling seamless steel tubes.

C. L. Huston, of the Lukens Iron and Steel Co., read a paper on "Segregation in Steel," in which he discussed present knowledge about the presence of manganese, carbon, sulphur and phosphorus in ingots and plates of boiler steel. Manganese he described as less apt to be segregated into certain locations than the others; such variations in character no steel maker could remedy even in part except by care in melting, refining, pouring, reheating and working. A zone of high carbon, sulphur and phosphorus existed, corresponding closely to the zone of gas holes from 1½ to 3 in. in from the surface of the ingot. In rolling, the cavities closed up and gave a sound plate, but one of a composition varying from that of the edges where test pieces were cut. The variations in any one plate were found to be almost as great as the total allowed range of test, so that if the hardening elements were sufficient to give required tensile strength at the edges there would be a higher range in the remainder used for the boiler. He had heard of little unsatisfactory service from soft steels, but of considerable where the tensile strength was pushed, in response to demands for greater steam pressures with the same weight of steel, to a point where the steel became brittle.

This paper evoked much discussion, in course of which it appeared that much high-test steel was being used though a standard requirement of below 65,000 lb. per sq.in. had been recommended. A new process was mentioned by Mr. Huston as showing promise of distributing the gas mentioned above; calcium fluoride is thrown into the steel at the proper moment, judged by the temperature, fluidity and condition of slag.

"Boiler Explosions: Their Cause and Prevention" was the subject of an important paper by S. F. Jeter, Supervising Inspector of the Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn. He stated that tube failures in water-tube boilers were of grave concern because of the difficulty of guarding by the usual inspection, and that the loss of life and limb from water-tube failures, relative to the proportionate number of such boilers in use, exceeded other classes of boiler accidents. He advocated government investigation of all boiler accidents. One statement in this paper seemed peculiar in view of the recent papers of Howard and Gow (see ENGINEERING NEWS, Feb. 1, 1912):

> No definite information is available regarding the distribution of stresses around an opening in a cylinder when subjected to internal pressure.

H. C. Meinholtz, of the Heine Safety Boiler Co., St. Louis, presented a paper, "Modern Boiler Shops," illustrated by views of the new plant of the Heine company. This paper described the more general features of design and was followed with "The Use of Compressed Air in Boiler Shops," by Thomas Aldcorn, of the Chicago Pneumatic Tool Co., New York City. This paper was largely a review of the installation it was important to make.

W. H. S. Bateman, of Philadelphia, presented "The American Boiler Manufacturers' Association—As It is and As It Should Be." This was a sketch of the early organization and the influence of recent commercial development on the society. To remedy the evident lack of interest of boiler manufacturers about the country (only 25% of which belong to this association) the author proposed organizing special sections for makers of (a) marine, (b) water-tube, (c) return-tube, (d) house-heating and (e) locomotive boilers. These sections were to be articulated with the main body in the way seen in other societies. He also proposed having a traveling representative to interest boiler makers in the association's activities and to present official recommendations to the various legislatures, commissions, etc., interested in protecting life and property.

By special invitation, H. J. Hartley presented "Generalities Pertaining to Boiler Manufacturing Plants," in which he pointed to some ways of securing the best quality of product at lowest cost—such matters as (1) convenient shop location, construction and equipment, (2) modern tools and best arrangement of them, (3) an efficient and effective organization, (4) an aim to prevent poor jobs, (5) superintendents and foremen with some knowledge of the business end of their work as well as mechanical ability and theoretical knowledge of their materials, (6) piece-work wage systems.

The report of the Committee on Uniform Boiler Specifications took up the Massachusetts boiler rules, which had been very generally approved in 1909 and for which action the association had been freely criticized. It was explained that all details of the Massachusetts rules had not been approved and that the official code of uniform specifications would continue as the foundation for the committee's work. Changes in the Massachusetts code, in the light of members' experience, had been formulated and were presented. These recommendations were adopted by the association and will be officially offered to the Massachusetts Board of Boiler Rules.

New York State Civil Service Examination for Assistant Civil Engineer

BY "SUBSCRIBER"

The New York State Civil Service Commission held an examination on Feb. 18, 1911, for assistant civil engineer, at a salary of $5 to $6 per day. At least three years' practical experience in civil engineering of a quality satisfactory to the Commission was required. In case of graduation in engineering from a school maintaining a standard satisfactory to the Commission, two years' experience since graduation was required.

The scope of the examination and the relative weights of the various subjects were as follows: Use of field instruments, survey methods and computations, structural mechanics and hydraulics, inspection of materials and work, and methods and practice in engineering construction, weight 10; experience and personal qualifications, weight 7; education, weight 3.

Competitors were required to be citizens of the United States and at least 21 years of age on the date of the examination. Non-residents of New York State were admitted to the examination subject to the Civil Service Regulation that in case the eligible list contains the names of three or more residents of New York State, they shall be preferred in certification over non-residents.

The time allowed for the written examination was eight consecutive hours. The examination comprised 14 exercises, in two parts, and carried a total weight of 280. It was required to take from the first part a sufficient number of questions to make up a total weight of not less than 55, nor more than 75, and from the second part sufficient to make 100 for both.

If more questions were taken, only those exercises amounting to the required total weight which obtained the highest credit were to receive consideration in fixing the average rating. The weight of selections might unavoidably overrun 100 by 5%, in which case the weight of the one receiving the lowest percentage rating would be reduced to make the total weight 100.

The use of slide-rules and logarithms was advised. If the statement of the conditions in any problem seemed inadequate, the competitor might assume any further data not inconsistent with that already given. Incomplete designs and computations were to receive credit in proportion to their value, in the opinion of the examiner, as part of the whole work required. Direct methods and orderly arrangement were to have weight in fixing the ratings.

The questions as here given do not follow the exact wording of the original questions. However, especial endeavor was made to fix the questions in mind, and, as they were written out almost immediately after the close of the examination, it is believed that the wording, in general, follows very closely to the wording of the original.

Of a total of 225 who took this examination, 157 passed. The highest rating was 94.55%, and the lowest 75%.

PART I

Select problems of a total weight of not less than 55 nor more than 75. Any reference books may be used.

1. Weight 30. It is proposed to build a reinforced-concrete cellular dam upon a moderately compact and somewhat pervious gravel. The dam consists of an inclined deck resting upon buttresses, and is not to serve as an overflow. The height above the ground surface is to be 35 ft., and the length 1000 ft.

(a) Weight 18. Compute the stresses of the several portions and determine the dimensions required, the amount and distribution of the reinforcement and the stability of the dam as a whole.

(b) Weight 12. Make detailed sketches of longitudinal and transverse sections, showing spacing and dimensions of buttresses, deck, footing, joints, etc.

2. Weight 30. A city derives its water supply from an intake in a large lake. The intake is in the form of a circular shaft 15 ft. in diameter. The water enters through five circular gates 48 in. in diameter, set with their centers 20 ft. below the surface of the water. The shaft is 60 ft. deep below the lake level and is concrete lined. From the bottom of the shaft a rectangular unlined tunnel 6x8 ft. in section leads out. The tunnel slopes down from the intake 1 in 800, and is 2000 ft. in length. It connects with two pipe lines 3000 ft. long, one a 48-in. riveted pipe, the other a 36-in. cast-iron pipe. Both pipes discharge freely into a sump under the pump pit. The grade of both is 1 in 1200.

(a) Weight 20. How much water is delivered to the pumps per day?

(b) Weight 10. If a leak of 50,000 cu.ft. per day occurs in the cast-iron pipe at a point midway between its ends what would then be the total quantity delivered?

3. Weight 25. From the pool below an overflow dam 500 ft. long the channel narrows uniformly to 150 ft. in width in a distance of 1200 ft., at which point there is a fall or cataract. The bed of the channel is rock and boulders and is level transversely with banks sloping 1 to 1. Assuming that the water has no velocity before leaving the upper pool find the depth at a point 100 ft. back from the fall when 6000 cu.ft. per sec. is discharged.

4. Weight 30. In excavating a trench section 15 ft. deep and 70 ft. wide through clayey material which is dry and compact and could be cut vertically without bracing, skeleton sheeting is used consisting of five 2x12-in. planks placed against the bank and held by 8x8-in. vertical braces set 6 ft. c. to c. with bottoms buried 2 ft. in the clay and the tops held up by 3x10-in. struts 16 ft. long, butting upon an 8x8-in. horizontal sill held at 2-ft. intervals by 2x4-in. stakes driven into the ground. Later the banks become soaked so that close sheeting is required.

(a) Weight 15. Sketch and describe in some detail what you consider the most inexpensive safe method of holding up the banks.

(b) Weight 15. Figure the stresses and determine the necessary sizes and spacing of the material required.

5. Weight 20. An erection traveler for a cantilever bridge erection consists of one-half of a 10-panel Howe truss, that is, a parallel chord truss with vertical web members in tension. The depth of the truss is 20 ft. and the panel length 15 ft. The truss is set over a flat car with trucks 30 ft. apart, each truck being under a panel point, leaving 45 ft. overhanging. A derrick with a 40-ft. mast and 70-ft. boom is located on the outer end on the upper chord, and a hoisting engine with boiler, etc., at the inner end.

(a) Weight 10. If the truss weighs 500 lb. per lin.ft. and the boiler, etc., 35,000 lb., what is the capacity of the traveler, assuming that the engine, derrick, etc., are amply strong?

(b) Weight 10. Figure the stresses in each truss member.

6. Weight 15. Two courses of a land survey from station A to station B, and from station B to station C, were checked by a triangulation survey from two stations D and E, both on the same side of the land lines. The following angles were read: ADC 55° 47′ 5″, CDE 48° 41′ 40″, AED 38° 18′ 45″, AEC 53° 21′ 50″. B is invisible from D and E, but the angles ABD 45° 22′ 35″, BDE 20° 50′ 00′ and CBE 35° 12′ 50″ were read. DE measured 2170.32 ft., and bearing given N. 15° 21′ 10″ E. Compute the length and bearing of AB and BC.

7. Weight 25. A roadway is to be constructed across a bay or cove. This cove is a swamp silted up from creeks debouching at this point. The average depth of water is 5 ft. The mud under the water is about 40 ft. deep, overlying hard rock. The distance across the cove from between earth hillsides is 800 ft., and the roadway grade is to be a level one, and 12 ft. above mean low water. The rise and fall of tide is 4 ft.

(a) Weight 18. Describe what you believe to be most advantageous method of constructing the crossing, both as to design and manner of building it. Show by sketches, or otherwise, details and dimensions essential to a stable and economical structure.

(b) Weight 7. Prepare an estimate of quantities and cost.

PART II

Answer questions of a total weight sufficient to make 100 when added to those of Part I.

8. Weight 15. A trunk sewer is built in the form of a full centered arch with springing line at invert, whose form is immaterial. The radius of the intrados is 8 ft. and of extrados 10 ft. 6 in. The crown thickness is 1 ft. This sewer is intersected at an angle of 30° by a 5-ft. circular sewer whose invert is flush with that of the larger one.

(a) Weight 10. Show in both horizontal and vertical projection the curve of the intersection of the interior surfaces.

(b) Weight 5. How much masonry is cut out of the trunk sewer by reason of the intersection?

9. Weight 30. A tunnel 4000 ft. long is to be driven through a divide at a depth of 80 ft. below the surface. The material to be penetrated is ordinary earth for 400 ft. from each end, and the remainder of the distance is a fairly solid slate with knotty streaks. The dip and strike of the slate are 16° and 30°, respectively. The section is 8x8 ft., rectangular, and the grade is uniformly 1 in 300. Water to the amount of 2000 gal. per hour is to be cared for. Show by sketches and descriptions how the work should be prosecuted, including the number of points of attack, spacing, depth, and location of holes, amount and character of explosives, methods of mucking, timbering, etc. Estimate plant and force required and progress to be expected, and from these the cost.

10. Weight 10. Give briefly the respective merits and field of usefulness of each of the following kinds of piling: Plain and treated woods, reinforced concrete, plain concrete with enlarged bottom, steel and wood sheet piling.

11. Weight 10. What practical difficulties are met with in measuring in the completed road the amount of stone placed in macadam highways? What other methods might be employed and what objections might be made to each?

12. Weight 10. Explain the formation of shale deposits as a geological phenomenon. What general classification of rocks is made? Describe the origin of the Palisades of the Hudson River valley.

13. Weight 10. Describe in detail what you consider the best method of rerunning old farm survey lines. Give the party needed, the progress expected, and the full procedure, particularly when your survey conflicts with old records.

14. Weight 10. What causes might render bituminous material that had previously been found satisfactory in tests defective when applied on the road?

15. Weight 10. What effect upon transit readings have each of the following defects: a bent spindle, bent standards, verniers eccentric and not opposite, cross hairs not centrally located in telescope? Which defects may be eliminated and how?

A Japanese Pioneer in Reinforced Concrete

In the "Minutes of the Proceedings of the Institution of Civil Engineers," Session 1910-1911, Naoji Shiraishi, a Japanese engineer, describes the construction by him in Kobe harbor, in Japan, of a reinforced-concrete warehouse.

The structure is not especially novel in the light of our latest reinforced-concrete buildings, but the description of its erection is very interesting in view of the independent original discovery by the Japanese engineer of certain properties of concrete that have been for some time known where concrete has been more generally usd, and of other experiments carried on by the author.

The building in question is a two-story warehouse, some 500x132 ft. in plan, facing Kobe harbor and opening directly on a wharf provided with modern freight-handling machinery. Of its design the author says:

The principal articles for storage are pressed bales of cotton and bags of rice, flour and beans. Hence the requirements for the floor strength are particularly exacting, and the ground and first floors were designed for a superimposed load of 350 lb. per sq.ft. The flat roof, however, is expected to have a live load of not more than 30 lb. per sq.ft. The floors are supported on columns connected by beams, of which the main spans are limited to 18 ft., though in special cases over double tracks this is increased to 27 ft. 6 in. span. The fewer columns used the more convenient it is for handling goods, but the large spans will then necessitate unsightly depths of beam due to the heavy loading of 350 lb. per sq.ft. Reinforced brackets were resorted to on the tops of columns to act as additional support to the beams.

The columns at the ground floor, sustaining an unusually heavy load, needed correspondingly strong reinforcement in order to reduce the inconvenience of a very large cross-section. They are, therefore, reinforced with four angles braced together by latticing, the sectional area being nearly 10% of that of the concrete.

The ground floor is at the same level as the platform, 2 ft. above the rails. It is paved with a top layer of asphalt 2 inches thick, beneath which is a concrete layer 3 in. thick upon a subfoundation of gravel well rammed. A simple concrete floor is liable to become dusty through abrasion under frequent carting, hence a finishing coating of asphalt was given.

The first-floor slab is 4½ in. thick reinforced with expanded metal, 8x3-in. mesh, and ¼x⅛-in. strand; its span is 4 ft. 6 in. in the clear. The roof-slab is 3 in. thick, similarly reinforced with metal of 3-in. mesh and ⅛x⅛-in. strand, its clear span being 4 ft. 10 in.

All outer walls forming the perimeter of the building are 6 in. thick, and the partition walls are 4 in. thick. They are all reinforced by vertical rods ½ in. in diameter and 1 ft. apart. Mere consideration of strength does not require 6 in. for the outer walls, but they are given this thickness, because thinner walls, according to the author's previous experience, conduct heat too freely and make the interior too warm on dry summer days.

The calculations for the various parts of the building were made by Mr. Considere's formulas, with some slight modification. In the case of the columns, the compressive stress of the 1:2:4 concrete was taken at 500 lb. per sq.in., and the ratio E_s/E_c at 15, whence the stress in the steel becomes $15 \times 500 = 7500$ lb.; i.e., the steel, in order to have the same deformation as the concrete, should be stressed to not more than 7500 lb. per sq.in. This disadvantage of limiting the working intensity of steel stress becomes the more conspicuous the heavier the reinforcement. Hence for the heavy reinforcements in the lower columns the steel was built up to act as an independent load supporter, the concrete being bound round with hooping. In such case the resistance of the concrete is greatly raised, and it is possible to approach the ideal of stressing the steel up to, say, 15,000 lb. per sq.in., and the concrete to $15{,}000 \frac{E_c}{E_s} = 1000$ lb. per sq.in., thereby securing the full play of the strength of both materials. The working stress for concrete in compression was taken at 500 lb. per sq.in., and that for tension was neglected.

In the construction of the building, Mr. Shiraishi had to proceed slowly, because of the limited knowledge of the material. He says:

While reinforced-concrete engineering has long since passed its experimental stage in the West, it is quite beginning in Japan. When the author built a small oil store three years ago, he dares to say it was the first specimen of a reinforced-concrete building in Japan, not to speak about its uses in other kinds of engineering works, such as piles and small foot bridges. He had, therefore, to obtain all of his information on the subject through reading.

And, he might have added, through experiment.

These experiments and studies took the following form:

EXPANSION JOINTS—In other buildings constructed in the same compound no cracks are observable in beams, columns and floor-slabs, but some considerable ones have occurred in walls, being doubtless caused by the expansion and contraction due to temperature. To avoid these cracks, expansion joints about ½ in. thick filled with asphalt were used where the walls joined on to the columns. Their object has been realized since the asphalt is seen squeezed out between the walls and columns in hot summer days, and cracks in walls have since been observable.

WATERPROOFING—The author when engaged in the construction of drydocks, found that a mortar made of pozzolana mixed with portland cement and sand was more impervious to water than that made of portland cement and sand only. This fact was experimentally shown by testing two hollow blocks, one of the said ingredients and the other of ordinary mortar, as to their relative impermeability, by means of hydraulic pressure inside. Water percolated rather freely through the ordinary mortar block, while under the same pressure the pozzolana-mortar block was practically impervious. Advantage was taken of this quality in preparing concrete for the outer walls, the proportion of ingredients being ½ part of pozzolana and ½ of cement to 2 parts of sand and 4 of gravel by volume. It was expected that thereby the walls exposed to rain could be kept in better condition than otherwise, and in addition three coatings of alum boiled with castile soap were applied; it is not, however, found possible absolutely to prevent moisture reaching the inside.

LAYING CONCRETE—In concreting the author began by thoroughly ramming layer upon layer to secure good results. But such tedius work within the narrow spaces of the molds and through complicated reinforcement, soon became inadmissible if the claimed advantages of reinforced concrete both in cost and speed were to be secured. For the present building, therefore, it was decided to use concrete in a semifluid state, and pour it into the molds, with the belief that if such were inferior to rammed concrete the diminution in strength would be amply covered by the factor of safety taken. The work thus progressed rapidly. In the meantime test specimens were made, some of rammed concrete and others of poured, to experiment upon their relative strength. When the experiments were conducted with specimens six months old the building had nearly been finished, but the results were in accordance with the assumption.

FALSEWORK—The falsework to support the molds was erected by a method peculiar to Japan, the elements being Sugi poles (Cryptomeria) and rough ropes made of dried stalks of rice. Any form of a small truss is rapidly and dexterously set up by the workmen, who, while standing on top of poles already erected, handle the additional members like professional jugglers.

IMPACT TESTS OF FLOOR SLABS—The author prepared a few experimental slabs with different kinds of expanded metal and Japanese cement. The object of testing was to find, first, the ultimate loading when slowly applied; second, the setting in of cracks through impact, and third, the deflections due to different loadings. For the first and third items the slabs behaved satisfactorily, giving factors of safety of 3 or even 4. These results were considered very satisfactory, the testing staff proudly pointing out to visitors the enormous strength of the slabs; impact tests, however, told a very different tale. Upon the supposition that pressed bales of cotton on the top story might accidentally fall from their piles on to the floor while being handled, it was arranged to use such a bale, weighing 600 lb., as the dropping load, so that the experiments might duplicate what would really happen. The slabs tested were all six months old, and were of the same dimensions as for the previous test, being also supported at two edges only. The bale, suspended from a crane, was dropped through heights of 1, 2, 3, 4½ and 6 ft., respectively. It was disappointing to find that slight cracks began to appear from the drop of only 3 ft., no matter what the specimen of cement used, nor what the type or amount of reinforcement was. With a drop of 6 ft., failure was complete in every case. Such resistance to impact was considerably less than expected, and the result of the tests was to give a sharp warning that heavy articles should be handled with great caution on floor-slabs.

Another interesting fact brought out from the impact test was observed by comparing the manner of failure of expanded-metal slabs and that of slabs with wire reinforcement. The expanded-metal slab, when it failed by impact, always sheared off in the direction of the strand, or diagonally, and even before failure, cracked always in the same direction, proving that the failure of the metal was always by such shearing long before the development of the ultimate tensile strength. With wire reinforcement, final failure of the metal no doubt corresponds with the ultimate strength of the wires. This fact, due to impact, may mean nothing detrimental to the expanded metal in case of slowly applied loads; but to be on the safe side, the author will in future calculations take as the cross-section of the strands the area divided by the secant of their inclination to the major diagonal of the mesh.

When the second floor was six months old, bales of pressed cotton were piled up to the allowable maximum loading of 350 lb. per sq.ft., but the deflection of the beams underneath was practically undiscernible with the apparatus used. Such is in accordance with the very small deflections calculated, amounting only to a few hundredths of an inch. The warehouse is now being used daily, each floor being often loaded to its full capacity.

The Administrative Control of Typhoid fever in New York City is being studied by an advisory "committee of expert sanitarians and physicians" selected by Ernst J. Lederle, Commissioner of Health, to examine the methods of control now practiced by the Department of Health, with a view to making suggestions for their improvement. The membership of the committee is as follows:

Prof. William T. Sedgwick, Massachusetts Institute of Technology, Boston.
Prof. George C. Whipple, Harvard University (and New York City).
Prof. C.-E. A. Winslow, College of the City of New York.
Daniel D. Jackson, Director of Laboratories of the Department of Water Supply, Gas and Electricity, New York City.
Dr. John W. Brannan, President of Bellevue and Allied Hospitals, New York City.
Dr. Alexander Lambert, and Dr. Herbert D. Pease, both of New York City.

The committee met for the first time on Feb. 15, 1912, in conference with Commissioner Lederle and other Health Department officials.

George Wallace Melville

As a naval officer, explorer, inventor and engineer, few Americans of the present time have gained wider fame and more universal esteem than the late Rear-Admiral George Wallace Melville. His death at his home in Philadelphia, Penn., on Mar. 17, terminated a long and distinguished career devoted almost wholly to the public service, begun at 20 years of age as a third assistant engineer of a steam frigate in the early days of the Civil War, and ending as Engineer-in-Chief and Chief of the Bureau of Steam Engineering of the United States Navy.

He was of Scotch ancestry; his father, Alexander Melville, although born in this country, received his education at St. Andrews University, in Scotland. George Wallace Melville was born in New York City, on Jan. 10, 1841; he was the oldest of three sons, all of whom served in the army or navy during the Civil War.

After preliminary training in the public schools and a scientific course at Brooklyn Polytechnic Institute, he was apprenticed to a machine-shop proprietor of the name of James Binn, in East Brooklyn. He was here at the outbreak of the Civil War, when he at once volunteered and was appointed a third assistant engineer. He served throughout the war and was an active participant in many important engagements.

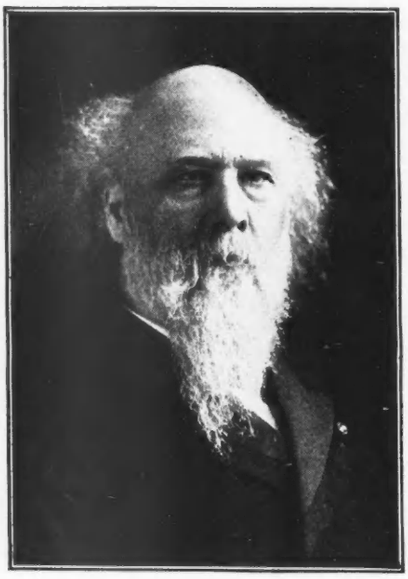
His fortitude and steadfast devotion to duty, which afterward served him so well in his arctic expeditions, was early shown. When, at his suggestion, it was proposed to ram the Confederate cruiser "Florida" in the harbor of Bahia, Brazil, in October, 1864, he only, and one fireman who refused to leave him, remained below decks on the "Wachusett" to operate the engines and boilers, which it was expected would be dislodged by the collision.

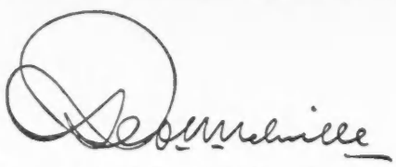
Following the end of hostilities, Melville continued in the Navy and was assigned to various naval stations and to various vessels until 1873, when a new field of adventure was opened to him. As engineer officer of the "Tigress" he made his first trip into the frozen North to hunt for Captain Hall's party of explorers.

His second and most famous Arctic trip was as engineer officer of the "Jeannette," a vessel fitted out by James Gordon Bennett, of New York, and commanded by Lieut. George W. De Long. This expedition sailed from San Francisco on July 8, 1879. The following September the vessel was icebound in Behring Sea, and for nearly two years drifted helplessly, finally being crushed so badly that she sank, June 21, 1881, 500 miles from the nearest land.

After a long and hazardous journey over the broken ice-fields, the party arrived, on Sept. 11, at a point separated from the Siberian shore by 90 miles of open sea. Embarking in three small boats, which they had dragged with them many miles over the hummock ice, they set forth for the distant haven. One boat was swamped soon after launching, and all on board perished. The one under the command of Melville succeeded in making the Siberian Coast only after its crew had suffered terribly from cold and insufficient food. The third party under De Long succeeded in making the shore, but ultimately perished. Their remains were afterward found by Melville after two resolute attempts to locate them.

Less than two years after his return to America, Melville was again ready to undertake another trip to the northward in search of Greely's expedition. In this





he was attended with early success, for in less than two months he had found Greely and his few surviving companions and rescued them from certain starvation. For his heroism in this and the two preceding expeditions, Melville was awarded a gold medal and advanced 15 points in rank by a special act of Congress.

After his arctic journeys were over he returned to his engineering work in the Navy Department. Under his direction as Chief of the Bureau of Steam Engineering over 60 vessels, aggregating 350,000 hp. had been constructed up to the time of the Spanish-American War. He was the designer of the triple-screw cruisers "Columbia" and "Minneapolis." During the Spanish-American War he devised the floating machine shop "Vulcan," which did much useful service in the fleet before Santiago, Cuba.

Rear-Admiral Melville remained the active head of the Bureau of Steam Engineering until 1903, when he was placed on the retired list. He had since made his home in Philadelphia, where, until recently, he was associated with W. H. Macalpin, and together they developed the Melville-Macalpin speed-reduction and transmission gear and dynamometer, described in ENGINEERING NEWS of Oct. 21, Oct. 30 and Dec. 9, 1909, Apr. 7, 1910 and Nov. 16, 1911.

Rear-Admiral Melville was a member of several learned societies and the recipient of many honors, both from his countrymen and in Europe. For many years he was one of the most noted members of the American Society of Mechanical Engineers, and was President of that society in 1899. In 1910, he was elected an honorary member.

A more detailed biography of Rear-Admiral Melville may be found in ENGINEERING NEWS, Jan. 19, 1899.

The Abolition of the Common Drinking cup on all railway trains and at all railway stations in Idaho, Washington, Montana, Minnesota and North Dakota was agreed upon at a recent conference of representatives of the boards of health of those states.

An Explosion in a Roundhouse of the Southern Pacific Ry., Mar. 18, at San Antonio, Tex., destroyed a locomotive and killed 32 men employed in the roundhouse and shops. About 60 others were injured. Many of these men were "strike-breakers." According to press reports, an examination of the wreckage revealed evidence that the accident was caused by nitroglycerine or some other high explosive rather than by a boiler explosion.

A Broken Rail Caused the Wreck of the 20th Century Limited on the New York Central R.R., Mar. 13, a few miles north of Poughkeepsie, N. Y. Fifteen or twenty passengers were injured, none fatally. The five rear cars left the track and four of them went over the embankment and were partially submerged at the edge of the Hudson River. The accident is ascribed, in the official statement issued by the railroad company, to a broken 100-lb. rail rolled in 1910.

A broken rail is assigned in press reports as the cause of the derailment of a Chicago, Milwaukee & St. Paul Ry. passenger train No. 22, near Oakwood, Miss., Mar. 12. Twenty persons were injured.

A broken rail is assigned in press reports as the cause of the wreck of a passenger train on the Chicago, Great Western R.R., Mar. 14, near Dunkerton, Iowa. Four cars left the track and 25 persons were injured.

A Record in Railway Operation through a particularly severe winter in the heart of the Rocky Mountains is claimed by the Denver & Rio Grande R.R. From Jan. 1 to Feb. 20, inclusive, 307 of 357 trains were operated on time, an average of 86.1%. The Cannon City local was on time every one of the 51 days and the Pacific coast train between Denver, Colo., and Ogden, Utah, was on time 46 out of 51 days. In some cases three locomotives were necessary to handle a light train.

A Frozen 6-in. Water Main, running from the Borough of The Bronx, New York City, under East River to North Brother Island, where are several departments of the City Hospital, was

thawed by electricity recently. The pipe had been frozen nearly a month, and it was expected to be necessary to remove and relay it. This was not an easy task, as the pipe was some 2000 ft. long and submerged from 50 to 80 ft. A bank of four 100-kw., 2000- to 200-volt transformers were set up on the Bronx shore. The pipe was cut at the island and shore ends and copper cables run from the transformers to these ends with a water rheostat in circuit. It required 15 men two nights and a day to lay the submerged cables. Electric-motor pumps were installed on the island to force water through if the ice should yield. Current was started on Mar. 7 and soon increased to 800 amp., and was kept on the pipe continuously. On Mar. 8 it was 1300 amp., on Mar. 9, 1500 amp., and on Mar. 10 and 11, 1800 amp. Early in the morning of Mar. 12 complete flow was unexpectedly established.

The New York Architecture and Engineering Exhibition, which was to have been held Mar. 25-30, has been merged with the New York Fire Exposition, constituting a department of fireproof construction and safety building equipment, and will be held Oct. 2-12. The exposition, as previously announced, will be at the 71st Regiment Armory, 4th Ave. and 33rd St., New York. Mr. A. C. Storey, 1269 Broadway, is secretary.

An International Rubber Exposition will be held in New York City in September at the new Grand Central Palace. Mr. A. Staines Manders, organizing manager of the exposition, announces that three prizes totaling $7500 will be offered during the exposition for the invention of the best method of making rubber nonslipping for pavements, roads, etc., or for any use to which it may be put in all atmospheres and for all kinds of traffic. The patent for the invention is to remain in the hands of the inventor. The money for the prizes has been subscribed by the producers of crude rubber and others connected with the rubber industry.

A Public Park and a Monument to mark the place in New Jersey where Washington landed after his famous trip across the Delaware in 1776 is proposed. A bill recently passed by the New Jersey legislature and signed by Governor Wilson provides for the purchase of the necessary land.

A Series of Mine-Explosion Tests, 14 in number, was completed on Feb. 24, at the experimental mine of the U. S. Bureau of Mines, Bruceton, Penn. (See Engineering News, Apr. 13, 1911.) The wall shelves and floor of the entries on this date were loaded with a total of 2 lb. of coal dust per linear foot, making 0.64 oz. per cu.ft. of air, or five times that theoretically necessary to use up all the oxygen. The loading in the main entry extended from the face to the mouth; it also was continued through the last crosscut into the parallel air course and along this for 200 ft., at which point a stone-dust barrier was erected. This consists of a series of thirteen 20-in. shelves across the passageway, 5 ft. apart and 5 ft. above the track; each shelf carried 200 lb. of stone dust. (This scheme was devised by Director J. Taffanel, of the Lievin Testing Station, in France, and is reported to have been generally adopted in French coal mines.)

Beyond this barrier the passage was loaded with coal dust for 50 ft. Small tufts of loose gun-cotton were placed at intervals about the mine to determine the extent of flame, in addition to the electrical recording instruments installed. The explosion was initiated by a blown-out 3-lb. shot of black powder, electrically fired. In 2½ seconds, a cloud of dust shot out the mouth of the mine, followed by a tongue of flame and a violent detonation. Smoke increased for a few seconds and then the current reversed and no smoke reappeared until ventilation was secured. It was found that flame came no closer than some 70 ft. of the mouth of the air course. The Taffanel barrier was smashed to pieces and the flame evidently passed it. However, there was practically no violence shown beyond. In previous tests, with the barrier closer to the origin of the explosion, the flame was always extinguished.

A maximum (static) pressure of 150 lb. per sq.in. was registered at 150 ft. from the mouth. The 3x4 hardwood shelving was displaced; the track ballast was lifted and concrete arches were broken. Outside the mine, gates recessed behind concrete arches were carried away bodily. A car 50 ft. from the entrance was blown 200 ft. across a ravine. The instrument records showed that the explosion traveled slowly at first, but rapidly increased in velocity up to 2100 ft. per sec., the maximum that could be recorded. The flame wave was much behind the pressure wave at first, but caught up rapidly as the entrance was approached. The Bureau of Mines intends to make systematic tests of similar barriers.

Personals

Mr. John M. Mack has resigned as President of the General Asphalt Co., of Philadelphia, Penn.

Mr. Harry E. Wilson, a lawyer, of Seattle, Wash., has been appointed by the Governor of Washington a member of the State Public Service Commission.

Mr. Arthur D. Little, President of Arthur D. Little, Inc., Chemists and Engineers, of Boston, Mass., has been elected a member of the corporation of the Massachusetts Institute of Technology. Mr. Little is President of the American Chemical Society.

Mr. Arthur E. Stilwell, President of the Kansas City, Mexico & Orient Ry., has resigned. The railway is now in the hands of a receiver, but it is reported that the company will be reorganized and the construction work will be resumed at an early date.

Mr. N. A. Williams, formerly Superintendent of the Denver & Rio Grande R.R., at Helper, Utah, has been made Superintendent at Salt Lake City, Utah, succeeding Mr. W. M. Bacon, resigned. Mr. J. T. Slattery, General Air-Brake Inspector, succeeds Mr. Williams at Helper.

Mr. Frederick L. Ford, M. Am. Soc. C. E., of the firm of Ford, Buck & Sheldon, of Hartford, Conn., has been appointed City Engineer of New Haven, Conn. Until he resigned on Mar. 16, 1911, he had been City Engineer of Hartford nine years and Assistant City Engineer for six years.

Mr. C. Lee Straub, Consulting Engineer, of New York City, formerly with the engine department of the Power & Mining Machinery Co., of Milwaukee, Wis., has been placed in charge of the lubricating department of the Richardson-Phenix Co., Hudson Terminal Bldg., New York City.

Mr. William C. Hammatt, M. Am. Soc. C. E., until recently Chief Engineer of Miller & Lux, Inc., and the San Joaquin & Kings River Canal & Irrigation Co., Inc., of San Francisco, Calif., has opened an office at 819 Foxcroft Bldg., San Francisco, for private practice as a consulting civil engineer.

Mr. John F. Stevens, M. Am. Soc. C. E., former Chief Engineer of the Panama Canal and more recently President of the Oregon Trunk Ry. and other railways of the Hill System in Oregon, is now President of the Jno. F. Stevens Construction Co., of 55 Wall St., New York City. This company has been incorporated under the laws of New York State to do general contract construction work and engineering work covering examinations and reports for valuation and other purposes.

Mr. M. V. Hynes, Division Engineer of the Cincinnati, Hamilton & Dayton Ry., at Dayton, Ohio, has been appointed Engineer of Maintenance-of-Way, succeeding Mr. F. H. Alfred, M. Am. Soc. C. E., whose resignation was noted in our issue of last week. Mr. I. F. White, Division Engineer at Indianapolis, Ind., succeeds Mr. Hynes at Dayton, and Mr. H. A. Cassil, formerly Chief Clerk in the engineering department, has been appointed Division Engineer, succeeding Mr. White.

Dr. Harvey W. Wiley has resigned as Chief of the Bureau of Chemistry, United States Department of Agriculture, a position he has held nearly 29 years. Dr. Wiley is a member of many learned societies in this country and Europe and is the author of numerous articles and books, scientific and popular. During the last few years he has gained an international reputation as a food chemist, and has led in the movement for the prevention of the adulteration of foodstuffs and the correct labeling of drugs and patent medicines. Dr. Wiley has not yet announced his intentions for the future.

Obituary

John Dickey Culbertson, President of the National Tube Co., of Pittsburg, Penn., died on Mar. 13, aged 67 years.

John Howell Welles, one of the engineers on the construction of the Minot's Ledge lighthouse, Boston Harbor, died on Mar. 2, at his home in New York City. He was 91 years old.

Rear-Admiral John M. Bowyer, U. S. N., retired, died on Mar. 15, at his home in Annapolis, Md. He was 59 years old. From 1902 to 1911 he was Superintendent of the United States Naval Academy.

Dr. Henry Wilson Spangler, Professor of Mechanical Engineering, at the University of Pennsylvania, died on Mar. 18, after a critical illness of many months. A biographical sketch of Prof. Spangler will appear in a later issue.

Herbert Lane Daniels, a civil engineer, of Paradox, Colo., and formerly with the United States Reclamation Service, committed suicide by shooting, on Mar. 9. He had been ill for several weeks from typhoid fever and his mind is believed to have been unbalanced. He was born in Fitchburg, Mass., in 1875, and attended the Worcester Polytechnic Institute, afterward entering Cornell University, where he graduated in mechanical engineering in 1897. After several years' experience in the East and Middle West he secured an appointment in the United States Reclamation Service in 1904 and was engaged in work on the Gunnison tunnel in Colorado. After the comple-

tion of this work he resigned and had since been connected with a private irrigation project in the Paradox Valley, Colo. He is survived by a widow, who was Miss Dorothy Streeter, of Fitchburg, Mass., and a son, 2½ years old.

Dr. John Bernhardt Smith, State Entomologist of New Jersey, and Professor of Entomology at Rutgers College, died on Mar. 12, at his home in New Brunswick, N. J. Prof. Smith was born in New York City, Nov. 21, 1858. He was educated in the public schools and later studied law. He was admitted to the bar in 1879 and practiced law for four years, when he was appointed Special Agent of the United States Department of Agriculture. Here he first became interested in entomology and in 1886 was appointed Assistant Curator of Insects at the United States National Museum. This position he held until 1889, when he was appointed Professor of Entomology at Rutgers College. Five years later he was appointed State Entomologist and has since gained a national reputation for his work in mosquito extermination. He will be remembered by readers of Engineering News as the author of an article in our issue of Sept. 1, 1910, describing the methods of mosquito extermination used in New Jersey. He was a member of many scientific societies, and in 1891 was given the honorary degree of Doctor of Science by Rutgers College.

Engineering Societies

COMING MEETINGS

AMERICAN SOCIETY FOR TESTING MATERIALS.
Mar. 28-29. Annual meeting at New York City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

NATIONAL DRAINAGE CONGRESS.
April 10-13. Annual meeting at New Orleans, La. Vice-President, E. T. Perkins, First National Bank Bldg., Chicago.

AMERICAN ELECTROCHEMICAL SOCIETY.
April 18-20. Annual meeting at Boston, Mass. Secy., J. W. Richards, Lehigh University, South Bethlehem, Penn.

AIR BRAKE ASSOCIATION.
May 7-10. Annual convention at Richmond, Va. Secy., F. M. Nellis, 53 State St., Boston, Mass.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 14-16. Annual meeting at Chicago. Secy., F. H. Wentworth, 87 Milk St., Boston, Mass.

MASTER BOILER MAKERS ASSOCIATION.
May 14-17. Annual convention at Pittsburg, Penn. Secy., H. D. Vought, 95 Liberty St., New York.

AMERICAN RAILWAY ASSOCIATION.
May 15. Semi-annual meeting at New York City. Secy., W. F. Allen, 75 Church St., New York.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
May 16-18. Annual meeting at Pittsburg, Penn. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 22-25. Annual convention at Chicago, Ill. Secy., D. B. Sebastian, La Salle St. station, Chicago.

National Municipal League—The annual meeting will be held in Los Angeles, Calif., July 8-12, with headquarters at the Hotel Alexandria. The secretary is Mr. Clinton Rogers Woodruff, North American Bldg., Philadelphia, Penn.

Railway Materials Association—This association was recently organized to advance the interests of its members in connection with the annual meeting of the Railway Storekeepers' Association. An exhibit will be held in connection with the coming annual meeting at Buffalo, N. Y., May 20-22.

American Institute of Mining Engineers—At a meeting of the New York Section to be held at the Engineering Societies Bldg., New York City, Mar. 26, Prof. James F. Kemp will give an illustrated lecture on "Iron Mines in Swedish Lapland." At the April meeting, to be held Apr. 12, Dr. Carlton Ellis will lecture on "Flameless Combustion" as developed by William A. Bone, in England.

Oregon Society of Engineers—The annual meeting was held at Seattle, Ore., Feb. 5. A paper was read by W. H. Crawford on "The Steam Power Plant at Redondo, Calif." Under the constitution, the terms of office of the secretary, the treasurer and one vice-president expired at this meeting and the following men were elected to these offices: Vice-President, W. S. Turner; Treasurer, F. A. Naramore; Secretary, J. C. Stevens, 605 Spalding Bldg., Portland, Ore. The secretary's report gave the present membership as 231.

Brooklyn Engineers Club—At a meeting held Feb. 29, Mr. M. N. Baker, Editor of Engineering News, gave an informal talk on "The Engineer as a Public Health Officer," in which he outlined broadly the work of protecting the public health and showed that a large share of this work belongs more naturally to the engineer than to the physician. Geo. C. Whipple, of New York City, and Wm. R. Copeland, formerly Chief Chemist of the Columbus, Ohio, water department, contributed to the discussion.

The annual engineering exhibit will be held at the club's house, 117 Remsen St., Brooklyn, Apr. 15-20.

International Congress of Applied Chemistry—The eighth congress, as previously announced in this column, will be held at Washington, D. C., and New York City in September, 1912. The opening meeting will be at Washington, Sept. 4, and all subsequent sessions of the congress will be held at Columbia University in New York City, Sept. 6-13. The preliminary announcement of the papers to be presented at the congress includes the following: "Combustion of Coal in Boiler Furnaces," L. P. Breckenridge, New Haven, Conn.; "By-Products of Coke Manufacture," N. Caro; "Peat as Fuel," Chas. A. Davis, Washington, D. C.; "The Waste of Coal in Bituminous Coal Washings," D. R. Delamater; "Fuel Oil vs. Coals," "Diesel Oils" and "Determination of Water in Fuel Oils," Irving C. Allen, Pittsburg, Penn.; "The Meaning of Certain Constituents in Coal Ash," S. W. Parr, Urbana, Ill.; "Notes on a Study of the Temperature Gradient of Setting Portland Cement," Allerton S. Cushman, Washington, D. C.; "Production of Ethyl Alcohol from Cellulose Raw Material," F. P. Dunnington, Charlottesville, Va. The secretary is Bernhard C. Hesse, 25 Broad St., New York City.

Wyoming Society of Civil Engineers—This society was recently organized by the engineers of the Big Horn Basin, at Basin, Wyo, with the idea of raising the standard of engineering work and increasing public confidence in the engineering development of the state. It was formed to promote engineering projects of value, to discourage wild-cat mining and irrigation schemes, to encourage legitimate business along engineering lines, to increase the confidence of the public and investing capitalists in Wyoming enterprises, to stand for careful and bona fide estimates of cost, to make easier the selection by employers of competent specialists in the various classes of work and to promote the diffusion of engineering knowledge and good fellowship among its members.

At the first meeting, a constitution and by-laws were adopted and the following officers were elected for the ensuing year: President, C. W. Atherly, Basin; Vice-President, H. T. Nowell, Basin; Secretary-Treasurer, M. D. Woolery, Thermopolis. A code of ethics and a recommended schedule of standard fees were ordered prepared for the next meeting, which is to be held at Basin, Wyo., Mar. 22, 1912.—Contributed by H. T. Nowell, Basin, Wyo.

American Highway League—The third annual meeting was held at the Hotel LaSalle, in Chicago, Feb. 26-27. The attendance was good, considering that membership in the association is limited to state highway departments. Representatives were present from the highway departments of Illinois, Iowa, Minnesota, Wisconsin and South Dakota.

A paper on "The New Wisconsin Plan" was presented by C. R. Hirst, of the Wisconsin Highway Commission. Mr. Nagel, of the Minnesota Highway Department, spoke on "The New Minnesota Plan." The effect of automobile travel on road surfaces was the subject of a talk by Mr. Hughes, of the U. S. Office of Public Roads. A. N. Johnson, State Highway Engineer of Illinois, discussed "Mixing vs. Penetration Method of Construction." He also described the testing of a reinforced-concrete bridge.

An illustrated paper on "Temperature Stresses in Concrete Bridges; Arch Analysis as Affected by Temperature," by C. S. Nichols, of the Iowa Engineering Experiment Station, and C. B. McCullough, of the Iowa Highway Commission, was presented. "Recent Results of Protective Coatings," an illustrated talk by Dr. John A. Schaeffer, described results of elaborate experiments with different kinds of paints as coatings for wood and steel structures. Prof. DuFour, of the University of Illinois, spoke of recent experiments made by him to determine impact allowances for bridges. Prof. J. E. Kirkham, Consulting Engineer, Iowa Highway Commission, spoke on "Distribution of Floor Loads for Bridges." Samuel H. Lea, State Engineer of South Dakota, spoke about road conditions in his state and referred to its present and proposed road legislation.

The date set for the next annual meeting was the last Monday in February, the place of meeting to be determined by the board of directors. The election of officers resulted as follows: President, Thomas H. MacDonald, Ames, Iowa; Secretary-Treasurer, C. R. Hirst, Madison, Wis.—Contributed by Samuel H. Lea, Pierre, S. D.